MAR 28 1925

Engineering Library

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VOL. CXXXIX.—No. 3611] LONDON: FRIDAY EVENING, MARCH 13, 1925 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

POINT RODDING, Steam Piping Quality.
Tenders due on the 27th March, 1925.
Tender forms obtainable from above. 8632

Architectural Draughtsman REQUIRED by the GOVERNMENT of NIGERIA for two tours of not less than 12 nor more than 18 months' service. Free passages and quarters and liberal leave on full salary. Outfit allowance of £60 on first appointment. Salary £600, rising by annual increments of £30 to £750, and thence by annual increments of £40 to £800 a year. Candidates, aged 25 to 35, must be A.R.I.B.A. and have had experience of hospital and general building work and have had good experience of quantities.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/13,438. 8624

Assistant Engineer REQUIRED for the PORT DEVELOPMENT DEPARTMENT of HONG KONG, for three years' service, with possible extension. Salary, £460, rising to £680 a year by annual increments of £20, payable locally in dollars at the Government rate of exchange, which is at present fixed at 2s. to the dollar. In addition, a strictly temporary exchange allowance of 20 per cent. of salary is at present paid, and thus at the present time the annual salary in dollars will be 5520 dollars a year. The current rate of exchange being now about 2s. 4d. to the dollar, the sterling equivalent of 5520 dollars is accordingly about £640. No income tax. Free passages. Candidates, unmarried, aged 24-28, must be regularly trained Civil Engineers and have passed the Institution of Civil Engineers' examination qualifying for Associate Membership or have obtained an exempting decree. Must be good draughtsman, well up in Levelling, Land and Marine Surveying, having some experience in the Design, Construction and Maintenance of Quay Walls and Piers.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,425. 8634

Assistant Engineers (3) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service, with possible extension. Salary £480 a year for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and thereafter to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30, preferably unmarried, must have had good general education and be (a) A.M.I.C.E. or hold equivalent qualifications, or (b) have passed the full examination of the Institution of Municipal and County Engineers. They must have had proper technical training and have had not less than two years' subsequent experience on large engineering or municipal works.—Apply at once by letter, stating age, qualifications, and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting reference M/13,422. 8618

Civil Engineer Required for the HARBOUR ENGINEER'S DEPARTMENT, COLOMBO PORT COMMISSION, CEYLON, for two years' service, with possible permanency. Salary, £850 per annum for two years, afterwards rising, if confirmed in the appointment, by yearly increments of £40 to £1050 a year. The post is at present non-pensionable. Free passages. Quarters provided, if available, for which rent is payable at the rate of 10 per cent. of salary, otherwise an allowance for rent in accordance with the usual scale is paid. Candidates, not over 40 years of age, must be fully qualified Civil Engineers, and have knowledge and experience in the general routine work of a Harbour Engineer's Office, Marine Surveying and Sounding, Design and Setting Out and the Construction of various Harbour Works, including Quays, Jetties, Warehouses, Railways, &c., and Dredging and the Removal of Rock and Laying of Moorings. The person engaged is expected to acquire a knowledge of the Tamil language, and pass a viva-voce examination in that language. He will not be eligible for confirmation in his appointment until he has passed this examination and is considered otherwise suitable.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/13,403. 8635

In the High Court of Justice 1924 M. No. 3182.
Chancery Division
Mr. Justice Tomlin
In the Matter of :—
LETTERS PATENT granted to DONALD BARNS MORISON in respect of an invention entitled "Improvements in and connected with Apparatus for Condensing Steam" dated the 26th day of March 1909 and numbered 7321 of 1909 and in respect of an invention entitled "Improvements in Surface Condensers" dated the 16th day of November 1910 and numbered 26,825 of 1910;
and
In the Matter of the PATENTS AND DESIGNS ACTS 1907 TO 1919.

Notice Hereby Given that the CONTRAFLO ENGINEERING COMPANY Limited and DONALD BARNS MORISON have by Originating Summons dated the 25th day of September 1924 applied that the TERMS of the said LETTERS PATENT may be EXTENDED and NOTICE IS HEREBY GIVEN that on TUESDAY the 7th day of APRIL 1925 APPLICATION will be made to the COURT that a DAY may be FIXED before which the said Summons shall not be in the paper for hearing and NOTICE IS HEREBY GIVEN that any person desirous of being heard in opposition to the said Summons must at least seven days before the said 7th day of April 1925 lodge notice of such opposition at the Chambers of Mr. Justice Tomlin Room 175 Royal Courts of Justice Strand London and serve a copy thereof upon the above-named Applicants.
Dated the 27th day of February 1925.
CLEMENT DENNIS and CO.,
3/c. Lincoln's Inn-fields, London, W.C. 2.
Solicitors for the Applicants upon whom all documents requiring service may be served. 8585

PUBLIC NOTICES

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, E.C. 1.
A SPECIAL COURSE of
SIX LECTURES
ON
"THE METALLOGRAPHY AND HEAT TREATMENT OF IRON AND STEEL,"
will be given on
THURSDAY EVENINGS, at 7 p.m., by
Mr. R. GENDERS, M.B.E., B. Met.,
commencing on March 19, 1925, as follows :—
March 19.—Wrought Iron and Shear Steel.
March 26.—Properties and Heat Treatment of Carbon Steels.
April 2.—Special Purpose Steels.
April 16.—Tool Steels.
April 23.—Defects in Steels.
April 30.—Cast and Malleable Cast Iron.
These lectures are open to the public without fee.
S. C. LAWS,
8598 Principal.

Northampton Polytechnic INSTITUTE,
CLERKENWELL, LONDON, E.C. 1.
HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT.
The Governing Body invite APPLICATIONS for the VACANT POST of HEAD of the ELECTRICAL ENGINEERING DEPARTMENT.
The salary scale at present applicable to the post is £700-25-900 (less an abatement of 5 per cent.). The period during which the present scale (and abatement) is operative expires on March 31st, 1925, when some revision may take place following an award of the arbitrator appointed in connection with the Joint Standing Committee on Teachers' Salaries.
The post is governed by the provisions of the Teachers (Superannuation) Acts.
Further particulars and forms of application may be had on application to the undersigned, to whom applications should be forwarded not later than April 18th.
S. C. LAWS, M.A., M.Sc.,
8617 Principal.

Great Southern Railways.
The Directors of the Great Southern Railways, Ireland, are prepared to receive TENDERS for the SUPPLY of the following MATERIAL :—
4000 Tons No. 90 R. Bull-head Rails (British Standard Section).
90 Tons Fish-plates for Ditto.
2500 Tons Cast Iron Chairs.
6500 Tons 85 lb. Flat-foot Rails.
160 Tons Fish-plates for Ditto.
950 Tons Cast Iron Sole Plates.
Specifications, forms of Tender (on which alone offers will be considered), and drawings can be obtained on application to the Company's Stores Superintendent, Inchicore, Dublin.
Tenders should be forwarded so as to reach the undersigned not later than 10 a.m. on Thursday, 2nd April, 1925, in the envelope provided for the purpose.
The Directors do not bind themselves to accept the lowest or any Tender.
C. E. RILEY,
Secretary.
Kingsbridge Terminus, Dublin,
March, 1925. 8609

PUBLIC NOTICES

Edinburgh Corporation Electricity Supply.
The Edinburgh Corporation is prepared to receive OFFERS for the following BOILERS, GENERATING PLANT, PUMPS, &c., situated at their Dewar-place, McDonald-road, and Leith Generating Stations :—
LEITH STATION.
Three Hand-fired Lancashire Boilers, each rated at 6000 lb. per hour, 160 lb. gauge pressure.
Two Babcock and Wilcox Boilers, each rated at 22,000 lb. per hour, with chain grate stokers, 160 lb. gauge pressure.
One Green's Economiser of 480 11ft. tubes.
Two Howden-Crompton D.C. Generating Sets, each 330 K.W., 460/550 volts, shunt or compound, non-condensing.
One Metropolitan-Vickers D.C. Turbo-Generator, 500 K.W., 460/550 volts, shunt or compound, complete with condensing plant, and cooling tower of 96,000 gallons per hour.
Two 44in. Carruthers' Compound Feed Pumps.
Two Exhaust Steam Feed-water Heaters.
McDONALD-ROAD STATION.
Nineteen Dry-back Marine Boilers, 160 lb. gauge pressure, each rated at 10,000 lb. per hour, fitted with mechanical stokers.
Seven Willans/Mather and Platt or Siemens D.C. Generators, each 750 K.W., 230 r.p.m., 460/520 volts.
Two Fraser and Chalmers/Brown-Boveri Exhaust Steam D.C. Turbo-generators, each 1200 K.W., 1250 r.p.m., complete with condensers and air pumps.
One Fraser and Chalmers/Siemens 6-Phase Mixed Pressure Turbo-generator, 1500 K.W., 374/419 volts, 3000 r.p.m., 50 periods, complete with condensers and air pumps.
One Condenser with Air Pump and Circulating Pump, suitable for a 1500 K.W. set, complete with 25 H.P. and 85 H.P. D.C., 500-volt motors.
All the above condensers are designed for inlet water at 70 deg. F. and an outlet temperature not exceeding 90 deg. F.
DEWAR-PLACE STATION.
Two Willans/Siemens D.C. Generators, each 325 K.W., 230 volts, non-condensing.
One Willans/Ferranti Single-phase Alternator, 150 K.W., 2000 volts, non-condensing.
The plant can be inspected any day between 9 a.m. and 5 p.m. by appointment.
Offers for any part or all of this plant must be sent to the undersigned not later than first post on Monday, April 6th, 1925, and endorsed "Offers for Electricity Plant."
ANDREW GRIERSON, S.S.C.,
Town Clerk.
City Chambers, Edinburgh,
13th March, 1925. 8620

Metropolitan Asylums Board.
TO LIFT ENGINEERS.
The Board invite separate TENDERS for the INSTALLATION of THREE ELECTRIC PASSENGER LIFTS in the New Buildings at Tooting Bec Hospital, Tooting Bec, S.W. 17, in accordance with the specification and drawing prepared by Mr. T. Cooper, M. Inst. C.E., M.I. Mech. E., Engineer-in-Chief. The specification, drawing, and form of Tender may be inspected at the Office of the Board, Victoria Embankment, E.C. 4, on and after 10 a.m. on Wednesday, 11th March, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a bona fide Tender sent in accordance with the instructions on the form of Tender and after the specification and the drawing has been returned.
Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 2.30 p.m. on Wednesday, 25th March, 1925.
G. A. POWELL,
Clerk to the Board.
March, 1925. 8589

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway Company.
The Directors are prepared to receive up to Noon on Friday, 27th March, TENDERS for the SUPPLY of :—
STEEL SLEEPERS, DISTANCE PIECES and KEYS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : 91, Petty France, Westminster, S.W. 1,
9th March, 1925. 8607

The Great Indian Peninsula Railway Company, 48, Copthall-avenue, E.C. 2, invite TENDERS for :—

1. STEEL RAILS AND FISH-PLATES	Fee £1
2. PRESSED STEEL SLEEPERS	,, £1
3. STEEL FISH BOLTS	,, 7s. 6d.
4. ROLLED STEEL CHECK-RAIL BARS AND FASTENINGS	,, 5s.
5. RAILWAY TICKETS	,, 7s. 6d.
6. SOLID-DRAWN STEEL BOILER TUBES	,, 7s. 6d.
7. STEEL WORK FOR BRIDGES	,, £1

Tenders are due by 11 a.m. on 24th March, 1925. Tender forms obtainable at above address. Fees not returnable. 8625

Corporation of Harwich.
FACTORY SITE.
The Corporation are prepared to LET on a Long or Short Lease a SITE eminently suitable for a factory.
The site is situate in Dovercourt and includes a chimney 250ft. in height.
The site abuts upon the railway and River Stour and the lease would include the right to use the dock in the immediate vicinity.
Area about two acres.
Further particulars can be obtained from the undersigned.
A. J. HANSLIP WARD,
Town Clerk.
Harwich, 20th February, 1925. 8458

The Corporation of Trinity House.
APPOINTMENT OF ASSISTANT ENGINEER.
APPLICATIONS are INVITED for the APPOINTMENT of an ASSISTANT ENGINEER. Age 28 to 35.
Candidates must be A.M.I.C.E. by Institution or equivalent examination. They should be quick and neat draughtsmen, proficient with theodolite and level, able to draw up complete specifications, take out quantities, and write reports. A thorough knowledge of building construction, ferro-concrete, steel structures and sea works essential. General all-round knowledge of engineering, including electrical and wireless work, is a qualification.
Commencing salary £400 per annum, rising to £600 per annum, plus bonus.
Applications, stating age, qualifications and experience, accompanied by copies of not less than three testimonials, to be addressed to the SECRETARY, Trinity House, London, E.C. 3, not later than the 20th March, marked outside "Applications re Assistant Engineer." 8559

"Works Training" Centre, DOVER.
WANTED IMMEDIATELY, TWO or THREE INSTRUCTORS in WOODWORK and METAL-WORK respectively. Applicants should have good workshop experience, with ability to teach, and a knowledge of and sympathy with adolescent boys.
The Centre is to be run experimentally in the first instance for the Summer and the Autumn Terms (April to December, 1925). If successful, the Institution may be continued and permanent appointments be made.
Applications, stating age, qualifications, experience, and salary required, should be sent, together with copies of three recent testimonials, not later than March 30th, to F. WHITEHOUSE, M.A. (Hon. Director, "Works Training" Centre), County School for Boys, Frith-road, Dover. 8614

SITUATIONS OPEN

ASSISTANT STRUCTURAL ENGINEER REQUIRED, with experience in drawing-office, estimating, sales office, and connection with London architects and engineers.—Address, with full particulars, 8588, The Engineer Office. 8588 A

CHIEF ENGINEER SALESMAN REQUIRED, to Take Charge of Sales Department of Large Firm supplying Centrifugal Liquid Purifiers. Unique opportunity for suitable man, who must have initiative, organising ability, extensive sales experience, and preferably some knowledge of centrifugals. State age and salary required and give full particulars of qualifications and experience.—Address, 8599, The Engineer Office. 8599 A

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SITUATIONS OPEN (continued)

CLERK of WORKS REQUIRED, with Good All-round experience in the construction of Civil Engineering Works, more particularly Roads, Bridges, Retaining Walls, Culverts, Concrete, and Sewering. The appointment for the first six months will be a temporary one at an inclusive salary of six guineas per week, with the prospect of a permanent appointment to suitable man.—Apply, stating age and experience, with copies of three recent testimonials, to CITY ENGINEER, Town Hall, Manchester. 8584 A

ENGINEER WANTED, to Take Charge of Mechanical, Electrical, and Maintenance Operations at a glass bottle factory. Must be experienced in controlling men and must have some experience of construction work.—Address, P386, The Engineer Office, stating experience and salary required. P386 A

ENGINEER, with Knowledge of Accounts, REQUIRED to Take Charge of Cost Office in Light Engineering Works, London district.—Address, giving details of experience, age, salary required, &c., 8571, The Engineer Office. 8571 A

EXPERIENCED ENGINEER WANTED for London office, to undertake sales for important firm, Combustion Engineers. Technically equipped with wide experience as to boilers, stokers, and all power-house problems. Good connection with leading consultants, chiefs, &c., essential. Must have compelling personality and capacity for getting entree to and for dealing with directorates and corporations, &c. State age, technical and sales experience, salary, when free.—Address, 8602, The Engineer Office. 8602 A

MAN WANTED, to Take Charge of Galvanising Department in a Wire Netting Works. Must have had experience in this branch of the trade.—Write, giving age, experience, and salary required in confidence, to Box 524, W. S. Crawford, Ltd., 233, High Holborn, London, W.C. 1. 8582 A

REQUIRED for Office in London of Representatives of large group of Continental Manufacturers of Railway Material, EXPERT. Must be thoroughly acquainted with advisory engineers and buying offices of foreign railway companies, with knowledge of engineering requirements.—Address, 8600, The Engineer Office. 8600 A

YOUNG ENGINEER REQUIRED, to Start Up and Demonstrate Concrete Mixers and similar plant, resident in London and willing to travel. State age, experience, and salary required.—Address, 8603, The Engineer Office. 8603 A

WANTED, DRAUGHTSMAN for Details and Installation of Oil Engines and Marine Auxiliaries.—Address, stating age, experience, salary required, and when at liberty, 8615, The Engineer Office. 8615 A

CAPABLE ENGINEER and DRAUGHTSMAN REQUIRED, to Take Charge of Small Engineering Drawing-office near London and be responsible for all design work and estimates to customers. Applicants must have had considerable shop and D.O. experience in the manufacture of Motor and other parts to fine limits. Good technical training essential.—Address, giving all information as to qualifications, experience, and salary expected, 8587, The Engineer Office. 8587 A

CHIEF DRAUGHTSMAN, Competent and Experienced, WANTED for Aircraft Drawing-office. Must be good organiser and disciplinarian with initiative and ability to get complete detail drawings produced to comply with requirements of chief designer.—Address, fully stating age, salary required, experience, when free, &c., 8601, The Engineer Office. 8601 A

CONSTRUCTIONAL ENGINEERS on the North-East Coast have a VACANCY in their Drawing-office for a fully qualified DRAUGHTSMAN as Chief Assistant.—Address, stating age, experience, and salary required, 8583, The Engineer Office. 8583 A

DRAUGHTSMAN REQUIRED Near London on G.W.R. main line, capable of taking charge of small drawing-office. Experience in design of Steam Fittings and Instruments desirable.—Address, with full particulars of experience, stating age, salary required, and when available, 8611, The Engineer Office. 8611 A

DRAUGHTSMAN REQUIRED by Engineering Firm in North of Scotland for Mechanical Handling Plants for Coal and other Materials; only men with complete knowledge of design and first-class experience need apply.—Address, stating age, full particulars of experience and salary required, 8633, The Engineer Office. 8633 A

DRAUGHTSMEN WANTED by Firm of Westminster Engineers. Must have thorough knowledge and experience of works in connection with Dock, Harbour and large Public Works Contracts.—Apply, giving full particulars of age, experience, and salary required, to Box 947, c/o Brown's, Tothill-street, Westminster, S.W. 1. 8561 A

DRAUGHTSMAN WANTED by Firm in the Midlands manufacturing Municipal Vehicles. Applicants should state age, experience, and salary required, and enclose copies of references.—Address, 8539, The Engineer Office. 8539 A

DRAUGHTSMEN WANTED by West of England Firm manufacturing High-class Small Machinery, chiefly relating to Printing and Cardboard Box Manufacture. Previous experience in this class of work not essential, but applicants will be required to give evidence of ingenuity and practical engineering ability. Applications, which should give age (preferably 20-30), training and salary desired, will be treated in confidence.—Address, 8596, The Engineer Office. 8596 A

ENGINEERING DRAUGHTSMAN, CHIEF, WANTED for Far East, age over 30, five years' agreement. Salary 425 dollars per month first 2½ years, 450 dollars per month second 2½ years. Must be capable of taking full charge.—Apply in own handwriting, giving testimonials, references, and stating full experience, married or single.—Address, "EAST," Wm. Porteous and Co., Advertising Agents, Glasgow. P384 A

EXPERIENCED LADY TRACER WANTED by Engineering Firm for Shop Details and Arrangement Drawings, N.W. district. State age, experience, and salary required.—Address, 8626, The Engineer Office. 8626 A

GOOD DETAILING DRAUGHTSMAN WANTED for London Constructional Engineer's Office. Must be used to Steel-frame 1909 Act work.—Address, stating age, salary expected, and previous experience, and when free, P373, The Engineer Office. P373 A

JUNIOR DRAUGHTSMAN, Quick, Accurate, Reliable, used to Pipe Work and Constructional Details; not less than 5 years' D.O. experience Give full particulars and salary expected.—Address, P396, The Engineer Office. P396 A

REQUIRED AT ONCE, TWO First-class STRUCTURAL STEEL WORK DRAUGHTSMEN for London. Used to detailing Steel-frame Buildings and taking Site Dimensions. Conversant with L.C.C. Steel Frame Act. State age, experience, salary required.—Address, 8631, The Engineer Office. 8631 A

WANTED, MACHINE SHOP FOREMAN; Must be used to dealing with high-class Engine Work on up-to-date production lines. State experience, age, and salary required.—Address, 8630, The Engineer Office. 8630 A

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road).

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex. G

SITUATIONS WANTED

AN ENGINEER,

Specialist in Aerial Ropeways, Chain and Rope Haulage, Ship Loading Plants, Etc.,

with rich Continental experience obtained on some of the largest plants in the World, OPEN TO CONSIDER PROPOSITION from established manufacturers or firms contemplating the manufacture of such plant.

Advertiser's experience includes estimating, negotiating orders, surveying and route selection, designing in steel and wood, erection and maintenance, and is further a well-known and recognised authority on such specialities. Will act as Consultant or otherwise.—Address, P398, The Engineer Office.

P398 B

A.M.I.C.E. (34), Locomotive, Mechanical, Steam and civil, works and D.O. experience, DESIRES POST as Assistant Manager, Works Engineer, or other progressive post. Good organiser, economy specialist, experienced in control of large staffs, some commercial knowledge.—Address, P360, The Engineer Office. P360 B

CHARTERED CIVIL ENGINEER REQUIRES AT ONCE APPOINTMENT as RESIDENT ENGINEER at home or abroad. Thoroughly experienced in reinforced concrete work, piling, wharves, sea defence, and harbour work. Highest references and testimonials.—Address, P390, The Engineer Office. P390 B

ENGINEER and CHEMIST. Vast Experience in power plant lay-out, erection, machine manufacture, works and D.O., DESIRES POSITION of TRUST, home or abroad.—Address, P372, The Engineer Office. P372 B

ENGINEER and WORKS MANAGER DESIRES CHANGE; held responsible positions, works and chief engineer; present works manager Radio Valve Co.; age 36.—Address, P374, The Engineer Office. P374 B

ENGINEER (32), Production Experience on Up-to-date methods, charge of D.O., tool design, planning, shop routine, practical, SEEKS POST offering scope, preferably London district.—Address, P327, The Engineer Office. P327 B

ENGINEER, Qualified in Erection and Maintenance of plant and machinery, D.O. and technical training, Indian experience with large concern (age 28), DESIRES POST.—Address, P370, The Engineer Office. P370 B

IRON, STEEL AND ENGINEERING SALESMAN.—Mr. J. FILKINGTON HUNT, having completed six years' engagement with Messrs. Hall and Pickles, Ltd., is now OPEN to DISCUSS the REPRESENTATION of a high-class FIRM in the Manchester and Lancashire area.—Confidential communications to be addressed c/o The Engineers' Club, Manchester. P351 B

MECHANICAL ENGINEER, Patentee, 14 Years' exp., DESIRES POSITION; engine-room and stokehold certificate, running and overhauls, steam, air, hydraulic, Diesel plant, gen. tools, jigs. Capable, age 31.—Address, P389, The Engineer Office. P389 B

POSITION as MANAGER, ENGINEER or ORGANISER REQUIRED by Engineer, M.I.W.E., A.M.I.P.T., with oil, waterworks or irrigation coy.; experience in finding and drilling for water and oil, also in irrigation works. Several years' experience with leading oil coy., superintending drilling operations and latterly with management. Good organiser. Considerable experience in economics, pipe lines, roads, light railways, motor transport.—Address, P385, The Engineer Office. P385 B

RESIDENT ENGINEER or CONTRACTORS' AGENT, railways, bridges, tunnels, roads, deep foundations.—Address, P318, The Engineer Office. P318 B

SHIPYARD FOREMAN and CHIEF DRAUGHTSMAN DESIRE responsible POSITIONS, specialists in up-to-date production of steel coasters, tugs, tankers, barges, &c.; also knock-down work for re-erection abroad.—Address, P376, The Engineer Office. P376 B

STEEL BUYER, Excellent Knowledge Home and continental markets, keen follower world conditions, trend of prices, &c., unique insight consumers' requirements, SEEKS APPOINTMENT, Buyer or Representative. Highest references.—Address, P375, The Engineer Office. P375 B

STEEL FOUNDRY MANAGER and METALLURGIST DESIROUS CHANGE; 6 years present position; excellent foundry record; experienced converter and Siemens.—Address, P357, The Engineer Office. P357 B

WELL-EDUCATED YOUTH, Just Left School, DESIRES to be APPRENTICED to a Firm of Engineers. Premium if necessary.—Address full particulars, P378, the Engineer Office. P378 B

WORKS and GENERAL MANAGER, Possessing brains, initiative, and exceptional organising ability, British and foreign experience; excellent references.—VALLON, Cabin, Prospect-crescent, Whitton, Twickenham. P391 B

YOUNG ENGINEER (23) DESIRES CHANGE in works of constructional engineers, with chance of advancement. Good D.O. and works experience, indentures.—Address, P381, The Engineer Office. P381 B

MECHANICAL DRAUGHTSMAN, 10 Yrs, Shops and D.O. exp., plant lay-out, machine design, &c., good mathematician, SEEKS POST; ex. refs.—Address, P387, The Engineer Office. P387 B

JUNIOR DRAUGHTSMAN, 4½ Years' Experience in all classes of gearing and general engineering, SEEKS CHANGE; any district.—Address, P392, The Engineer Office. P392 B

FOUNDRY FOREMAN.—A SITUATION WANTED by a first-class Moulder and Foundry Organiser. Used to control of men, mixing and melting of metals, iron and non-ferrous. Excellent references.—Address, P395, The Engineer Office. P395 B

SITUATIONS WANTED (continued)

A.M.I.C.E., M.I.A.E., and M.Sc. in Engineering.—A first-class ELECTRICAL and MECHANICAL ENGINEER, holding the above degrees and with the following experience, is PREPARED to CONSIDER OFFERS of APPOINTMENT.

Four years' university training, eighteen years' works and office experience with well-known English firms; has held responsible positions on general engineering and automobile trades.

Address further particulars, P367, The Engineer Office. P367 B

PARTNERSHIPS

IF YOU ARE SEEKING

A PARTNER or PARTNERSHIP

or wish to buy or sell a

BUSINESS or WORKS

Write:

WHEATLEY KIRK, PRICE & CO.,

46, Watling Street,

London, E.C. 4.

Established over 70 years.

EDUCATIONAL

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Reorganisation at Crewe.

Alterations, estimated to cost nearly half a million sterling and designed to make the Crewe works the most efficient of their kind in the country, have, it is announced, been decided upon by the directors of the London, Midland and Scottish Railway Company. At present the works have an annual capacity for the production of 70 new engines and for dealing with 1200 heavy repair jobs, besides other classes of railway work. When the projected alterations and additions have been completed, these figures will be increased by nearly 50 per cent. The old erecting shops are to be reorganised and equipped with high-speed electric cranes and a large new erecting shop is to be built. An extensive portion of the existing works is to be given over exclusively to the building of boilers, and all the steel plant is to be remodelled and supplied with newer and larger furnaces and other equipment. The alterations, it is stated, have been rendered necessary by reason of the increased size and weight demanded in modern locomotives, and the consequent increased facilities required for their construction and maintenance.

Steel Houses of the Nissen Type.

Colonel Nissen is well known by reason of his association with the Nissen type of hut, so extensively used during the war period. During the last few years, however, he has, we understand, given considerable attention to the use of steel for house construction and the application of engineering methods to cottage building, with a view to reducing costs and increasing the production rate. On Tuesday a pair of steel-framed cottages designed by Colonel Nissen were opened for public exhibition at Yeovil. The architects were Messrs. Petter and Warren, of Yeovil. It is hoped that if the houses are erected in any number on a given site, the cost of the Nissen type of steel-framed house will not exceed £800 a pair, including the foundations and all the necessary fittings. A concrete foundation is employed, and for every pair of cottages there are seven steel ribs, which are bolted to the concrete and serve to carry the roof. Wood purlins are attached to the steel ribs, and concrete blocks are used for the walls and gables of the cottages. The roof is formed of plates, with a metal core, which is protected by a bitumen asbestos waterproof covering. This type of steel-framed house can be erected, it is stated, almost entirely by unskilled labour, but bricklayers will be employed on the building work connected with the chimneys. The new houses have been approved for the Government subsidy and sanction has been obtained for a long-period loan covering the cost of their construction.

British Marine Oil Engine Developments.

At the annual presentation of prizes gained by the apprentices of the Hartlepool Engine Works of Richardsons, Westgarth and Co., Limited, Mr. Tom Westgarth made some reference to the marine oil engine development work which is being carried on by the firm. Referring to the two sets of twin-screw machinery installed in the Furness-Withy ships Sycamore and Tramore, he stated that after nearly a year of service the engineers of both these ships found their engines to be pleasant and easy to work, which spoke well for their design and the workmanship put into them. Machinery of the four-cycle single-acting type was, he remarked, of necessity very large and very heavy, and consequently very costly when built for high powers. The firm had found that it could not hope to compete with foreign engine builders if it did not produce engines capable of developing increased power for the same weight, and consequently the oil engine department of the works was busily engaged on the design and development of a two-stroke double-acting engine, with the same cylinder diameter—24½in.—as that used in the single-acting engines already built. Several of the patterns for the new experimental unit were nearly ready for the foundry, and it was the firm's intention to push ahead with the new engine so that as soon as possible it could place on the market a marine oil engine which it hoped would defy all competition. Mr. Westgarth appealed to all the apprentices who would work on the engine to put into it the very best workmanship possible.

The Rating of Machinery.

The report recently published of the Inter-Departmental Committee on the Rating of Machinery and Plant, to which we referred in a Journal note in our issue of February 20th, has not met with the approval of the Machinery Users' Association. That body represents over 10,000 manufacturers and traders using machinery, and was founded in 1889 with the express object of securing a revision in the laws and customs relating to the rating of machinery. Far from approving the Committee's recommendations, the Association is entering "the most vigorous protest that it is possible to make" against them. It sees in them a suggestion for the further shackling of capital and labour and the trade of the country. The Association demands that the machinery and plant in the Committee's second class—that is to say, loose, portable or "tenant's" machinery, as distinct from machinery and plant forming part of the hereditament—shall be entirely exempt from local taxation. The Committee's proposal was that such machinery should be assessed by professional valuers at periods not greater than five years, and that it should be taxed at only 25 per cent. of the full rate. The Association is once again promoting a Bill in Parliament, under which the value of a hereditament used for the purposes of any trade would be fixed solely with reference to the buildings and structures, the plant and equipment for producing, controlling and transmitting power for heating, lighting, cooling, ventilating and draining purposes for the supply of water or for fire protection purposes, the lifts and elevators and the railway and tramway lines and tracks with which the hereditament may be equipped. All other machinery, whether driven by hand or foot power or otherwise, the Association regards as personal property, and as such the Bill excludes it from assessment. The Bill is down for second reading on April 3rd.

Round the World in a Lifeboat.

An announcement has just been made of a severe test which it is proposed to put upon the crew and equipment of a lifeboat in the near future. Captain Hitchens, of the coastguard station at Pendeen, near Penzance, and three companions, one of them being a wireless operator, intend to set out for a voyage round the world in an open lifeboat, 39ft. long by 9ft. 6in. beam. The boat once belonged to the Lifeboat Institution and has been fitted with an auxiliary oil engine of 15 horse-power. It is proposed to set out from the Thames in May, cross the Atlantic, go through the Great Lakes, down the Mississippi, through the Panama Canal, across to New Zealand, round Australia, over to South Africa, round the Cape, then to Buenos Ayres, Rio, &c., and so back. The voyage is expected to occupy two and a-half to three years and should test the men and boat to the utmost. The trip across the Indian Ocean alone is one stretch of 4600 miles and the whole itinerary covers some 38,000 miles.

Large Destroyers for Japan.

According to Japanese Press reports, a series of very large destroyers is about to be laid down in that country. The first-class boats at present being built for the Japanese Navy are of 1400 tons, designed for a speed of 34 knots, and will mount four 4.7in. guns, with six tubes. The vessels now projected, however, will displace about 3000 tons, thus exceeding in size the largest flotilla leaders hitherto constructed for any navy. Details of their engine power and armament have not yet been received, but they are expected to have a speed of 35 knots and will probably carry four or five 5.5in. guns. Minelaying equipment is also likely to be provided. These new destroyers may turn out to be modified versions of the small cruiser Yubari, completed in August, 1923, which has proved very successful in service. Although only 3100 tons in displacement, she is able to steam at 33 knots. Her armament comprises six 5.5in. guns, one 12-pounder A.A. gun, and four torpedo tubes, all disposed on the centre line. The curious arrangement of her funnels gives this ship a distinctive appearance. Destroyer dimensions have steadily advanced in the past ten years, some recent vessels of this type being comparable to light cruisers in tonnage and fighting power. During the war Germany built boats of nearly 2300 tons, and the French flotilla leaders of the "Jaguar" class displace 2359 tons. Our largest leaders are the seven units of the "Admiralty" class, which displace 1800 tons. The new Japanese vessels will therefore far surpass all existing craft of their nominal type. It is interesting to note that they are only 500 tons smaller than our famous light cruisers of the "Arethusa" class, which were begun a year or two before the outbreak of the war.

The Air Ministry's Helicopter Competition.

In May, 1923, the British Air Ministry offered a series of prizes totalling £50,000 in connection with a competition for flying-machines of the helicopter type. The conditions laid down for fulfilment were severe—so severe in fact that many held them to be intended other than seriously. To hover for half an hour at 2000ft. in a wind blowing at 20 miles an hour, to complete a 20-mile closed circuit at 60 miles an hour, and to alight with engine shut off at 500ft. within 100ft. of a designated mark on the ground were far beyond the poor attainments of any helicopter in existence at the time the conditions were published, and are as far beyond the attainments of any such machine of which we know anything to-day. The entries for the competition closed at the end of April, 1924. It is understood that fifteen were received. The entrants were allowed a year in which to complete the tests. That period has all but passed, but so far, it is learnt officially, none of the entrants has even submitted a machine let alone demonstrated its capabilities. In these circumstances the Air Ministry is not abandoning the competition, but in accordance with a clause in the original conditions is arranging to re-offer the prizes in a second competition. Entries for this competition must be received by the end of next month, and to secure a prize a machine must complete the tests specified before April 30th, 1926. Those who entered the first competition, it is intimated, must enter their machines afresh for the second "if they desire to compete therein," as the Air Ministry's announcement says. The competition has certainly the merit of keeping interest in the helicopter alive at little expense to the taxpayer.

Stainless Silver.

A new silver alloy which is claimed to be more resistant to staining than any other so far produced was introduced to the members of the Silver Trade Technical Society and the local section of the Institute of Metals at Sheffield on March 5th. This alloy has been made by Wm. Turner and Co. and contains 92¼ per cent. of silver, but the other constituents were not revealed. So far only about 600 ounces have been manufactured. It has been made up into various articles by several firms, which have reported that, except as regards buffing and finishing, it is easier to work than standard silver. It is, we understand, extremely ductile, stands heat well and can be soldered readily. A test carried out at the Applied Science Department of Sheffield University showed that the new alloy was hardly stained at all when exposed to corrosive gases and that the faint discoloration which was produced could be easily wiped off with a dry leather. A few additional particulars regarding this interesting material will be found elsewhere in this issue in our Sheffield Correspondent's weekly letter.

Board of Trade Surveys for Foreign-built Ships.

Cases are somewhat rare in which the Survey Department of the British Board of Trade is required to supervise the construction of British-owned ships in foreign yards. Such a position, however, has arisen, we are given to understand, in connection with the order for a 2500-ton passenger-carrying ship which was recently placed by the Newfoundland Government with the New Waterway Shipbuilding Company, of Schiedam, Holland. When placing the order for the ship with the New Waterway Company, the Newfoundland Government expressed its desire that the vessel should be constructed under the survey of the British Board of Trade. The position is further complicated by the fact that the orders for the main castings have been placed by the Dutch company—presumably on the grounds of economy—with the Skoda Works, of Prague, Czechoslovakia, and if the wishes of the owners are to be met, surveys will have to be made both in Holland and Czechoslovakia. The excellence of the work of both the foreign firms here referred to is not to be questioned, but it does seem somewhat of an anomaly that a Government Department, the cost of which is directly contributed to by British shipbuilders, shipowners and taxpayers, should be called upon to assist in the execution of contracts placed on the Continent, even although it has been requested to do so by the Government of a portion of the British Empire.

The Late Mr. Robert Harvey.

Mr. Robert Harvey, who died at Glasgow on Monday last, was well known in the engineering industries of Glasgow and the West of Scotland. Throughout the larger part of his professional career he was actively associated with the manufacture of sugar machinery, and it was only a few years ago that he resigned from the chairmanship of the Harvey Engineering Company, Limited, of Kinning Park, Glasgow. Mr. Harvey's family was closely associated with early engineering developments in Glasgow. His father, Robert Harvey, sen., was an engineer with David Cook and Co., and succeeded to the business of that firm in 1870, when he started new works in Kinning Park, with his sons, Robert and William. Robert Harvey the younger was born in Glasgow, and was educated at Glasgow High School. He served his apprenticeship with David Cook and Co., and gained additional experience with Randolph, Elder and Co., of Govan, and a London firm of sugar machinery manufacturers. Later, he returned to Glasgow, and became the head of the Kinning Park works. In 1886 Mr. Harvey was joined by Sir William M'Onie, and the firm of M'Onie, Harvey and Co., Limited, was formed with Mr. Robert Harvey as the managing director. At a later date the title of the firm was changed to the Harvey Engineering Company, Limited. In addition to his keen interest in the historical side of engineering in general and of sugar machinery plant in particular, Mr. Harvey was a water-colour artist of considerable ability. In 1916 he presented to the Corporation of Glasgow several interesting original drawings of early marine engines and sugar machinery, together with a short history of his firm. He was unmarried, and is survived by two brothers, of whom one is Mr. William Harvey, his business partner.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XI.*

PERIOD 1846–1849 (*continued*).

Three-cylinder Engine.—A design of locomotive with three cylinders was patented by Isaac Dodds in 1839, in which two outside cylinders placed at the side of the fire-box drove the leading wheels, and the inside cylinder under the smoke-box drove the middle wheels. There was a small pair of carrying wheels behind the fire-box.[1] There is no evidence that such an engine was ever built.

In 1846 R. Stephenson and Co. built a three-cylinder engine of the "rear driver" long boiler type—Stephenson and Howe's patent. The three horizontal cylinders were in the same transverse plane, and placed between the two front carrying axles. The rear driving axle being in front of the fire-box allowed of a crank axle with a central throw for the inside cylinder, which was 16¾in. diameter by 18in. stroke. The two outside cylinders, each 10½in. by 22in., drove the same axle by means of crank pins in the wheels. Both outside cranks were on the same centre, *i.e.*, at 0 deg. with each other, and were 90 deg. in advance of the inside crank. The driving wheels were 6ft. 6in. diameter. Since both outside pistons always moved in the same direction, and the inside piston was on the centre line of the engine, it resulted that there was no "swaying" or nosing couple, though the longitudinal fore and aft surging force would be greater. According to the patent specification the arrangement was primarily intended to prevent alternate lifting of the engine due to the difference between the upward pressures on the slide bars on each side of an outside cylinder engine with cranks at 90 deg.

The engine was tried on the L. and N.W.R., and on a special train in April, 1847, ran with five carriages from Wolverton to Coventry, 41 miles, in 42 minutes.[2]

In 1853 it was reconstructed by Messrs. Stephenson for the York, Newcastle and Berwick Railway as a 2–2–2 engine with middle driving wheels, and the three cylinders in line with the smoke-box. The outside cylinders were fixed between the inside and outside frames. The driving axle had bearings in the inside frames only, and the carrying axles in the outside frames. The left-hand excentrics actuated the valves of the inside cylinder, and the right-hand excentrics the valves of both outside cylinders through the medium of a cross shaft. The engine in this form worked for many years on the North-Eastern Railway.[3]

Bar-framed Engines—Bury Type.—At the end of 1845 Bury, Curtis and Kennedy were compelled by force of circumstances to adopt the six-wheeled engine, but retained the bar frames. Most of their six-wheeled engines were of the 2–2–2 and 0–4–2 types. The driving and trailing horns were welded to the horizontal bars, but the leading horns were bolted on. More detailed particulars of Bury's later practice were given in the writer's article in THE ENGINEER of February 2nd, 1923, to which reference may be made. The firm's last bar-framed engine was put to work early in 1850 on the Shrewsbury and Birmingham Railway, but a number of four-wheeled bar-framed goods engines of Bury's type, with tall haystack fire-boxes, were built by W. Fairbairn and Sons until 1861, after which bar frames completely disappeared from British practice for home railways.

"Standard" Passenger Engines, Inside Cylinders.—From 1846 onwards there was a great development of John Gray's mixed framed engine, with inside bearings only for the driving axle and outside bearings for the leading and trailing axles. Gray himself designed twelve express engines for the London and Brighton Railway, which were generally similar to his original Hull and Selby engines of 1840, but of larger dimensions. The cylinders were 15in. by 24in., and the driving wheels 6ft. diameter. They carried a pressure of 100 lb., and, in accordance with Gray's sound ideas, the boiler centre was pitched 6ft. 3¼in. above rail level. These engines, which were fitted with Gray's "horseleg" expansion gear, were built in 1846–8 by Timothy Hackworth at Shildon, and in appearance were very similar to the Hull and Selby engines illustrated in THE ENGINEER, October 15th, 1920, page 370.

Gray's design was the immediate origin of the celebrated Jenny Lind engines—Fig. 66—designed by David Joy and built by E. B. Wilson and Co., Leeds, from 1847 onwards. An account of the steps which led to the design was given by Mr. Joy in THE ENGINEER, May 22nd, 1896, page 527.

The cylinders were 15in. by 20in., driving wheels 6ft., carrying wheels 4ft., and wheel base 7ft. + 6ft. 6in.; the tube heating surface was 720 square feet, fire-box heating surface 80 square feet, total 800 square feet. The boiler pressure was 120 lb., or 20 lb. higher than in Gray's engine, and to this the great success of the "Jennys" may be largely attributed. The use of this higher pressure was due to James Fenton. In one respect Messrs. Wilson apparently did not venture to follow Gray's example, for the boiler centre was only 5ft. 9in. above rail level, or 6½in. less than in Gray's engine. The weight in working order was slightly more than 24 tons, of which the driving wheels carried 10 tons. To allow of a wide fire-box, the inside frames terminated at the front of the casing, the throat plate being flanged outside to overlap the frame. The feed pumps were fixed to the outside frame and actuated by connecting-rods fixed in the boss of the driving wheels. Unlike Gray's engine, which had the designer's "horseleg" motion, the "Jennys" had Stephenson link motion suspended on one side only. A sectional drawing of the class appeared in THE ENGINEER, March 6th, 1896.

An engine similar to the "Jennys" was T. Hackworth's "Sanspareil," which came out in December, 1849, and was the last locomotive built by him. The Sanspareil is shown in Fig. 68, and the most noticeable external feature is the small number of spokes—ten—in the 6ft. 6in. driving wheels. They were of circular section and of extra sectional area, but there was a large unsupported portion of the rim between each spoke. The wheels were of solid wrought iron. The outside frame was welded throughout, though this was by no means the first example of welded frames. The longitudinal seams of the boiler were also welded, and the junctions with both smoke-box and fire-box casing were made by welded flanges in place of riveted angle irons. The dome was also welded, and flanged out of a single plate. The fire-box had a roof of semi-circular shape, stayed by longitudinal girders.

The cylinders were 15in. by 22in., and placed horizontally. The heating surface was 1188 square feet, but the grate had an area of only 11 square feet. Total weight in working order, 23¾ tons, of which 11 tons 4 cwt. rested on the driving wheels. Further particulars of this engine and of the peculiar slide valves with which it was fitted are to be found in "Timothy Hackworth and the Locomotive," by Robert Young. The Sanspareil was purchased by the York, Newcastle and Berwick Railway, and ran for many years on the North-Eastern Railway.

Another express engine for the same railway, also with mixed framing, was built by R. Stephenson and Co. in 1849, and is described in Mr. J. G. H. Warren's book. The cylinders, 16in. by 20in., were inside, but the steam chests were outside, and the excentrics were placed outside the driving wheels. This arrangement, which has appeared from time to time in locomotive design, had the fault that the steam chests were exposed to the current of cold air, and consequently liable to crack, and in the particular design under consideration the exhaust steam was carried round the bottom of the cylinders to the blast pipe, thereby extracting heat from them. The cylinders were firmly secured to both inner and outer frame plates by flanges attached to each, and they were also bolted together on the centre line of the engine. The reason for the outside steam chests and excentrics was not given, but as there was plenty of room on the crank axle for inside excentrics, the probability is that accessibility to the steam chests was the main consideration. Between 1848 and 1854, not only Messrs. Stephenson, but also the Vulcan Foundry, Jones and Potts, and R. and W. Hawthorn built a number of engines with outside steam chests, though in the case of Hawthorn's engines the reason for the design was different.

The boiler was slightly oval, having a vertical diameter of 3ft. 10in., and a horizontal one of 3ft. 9in., but it was not stayed transversely. The driving wheels were 6ft. 7in. diameter, and the total wheel base 14ft. 6in. In this connection it may be noted that the short wheel bases of two or three years earlier were now discarded. Another point of interest is that the boiler centre was 6ft. 6in. above rail level, and showed that Messrs. Stephenson had seceded from the advocates of a low centre of gravity. It is significant that Robert Stephenson, during the discussion on Crampton's paper (I.C.E., 1849) stated that he "had travelled with the utmost steadiness on an engine of which the centre of gravity was as high or higher than any he had previously seen, and he therefore denied that the steadiness of an engine was entirely caused by an extremely low centre of gravity."

The inside frames, with which the driving horns were forged solid, extended from the front buffer beam to the front of the fire-box casing, but there were brackets riveted to the front of the casing, with plates which embraced the ends of the inside frames, and allowed for expansion of the boiler. A somewhat similar arrangement was embodied in Hackworth's Sanspareil, but the latter was in one respect better in that the draw bar was attached to a pin through a short drag-box under the footplate, whereas in Stephenson's engine the pull was taken directly from the fire-box by means of an angle iron riveted to the casing. Stephenson's engine weighed 25¼ tons in working order, of which 11 tons were on the driving wheels.

The weight distribution of all these later 2–2–2 engines had been considerably improved, since the proportion of weight on the driving wheels was reduced from about 50 to about 43 per cent. of the total, and the leading wheels were more favourably loaded.

The firms of Sharp Bros., W. Fairbairn and Sons, and R. and W. Hawthorn did not depart from the type with outside sandwich frames and bearings for their passenger engines. Hawthorn's 7ft. 2–2–2 express engine Plews for the York, Newcastle and Berwick Railway was illustrated in THE ENGINEER, July 14th, 1922. The steam chests were outside, as in Stephenson's engine above, but were placed between the inside and outside frames, the excentrics being outside the driving wheels and inside the outer frames. In this case the object was to keep the boiler,

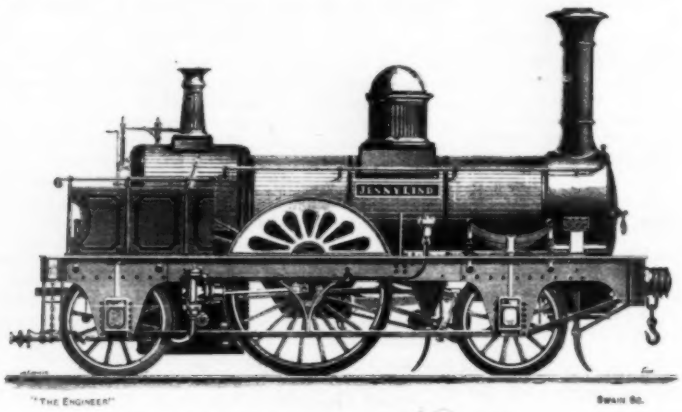


FIG. 66—"JENNY LIND," E. B. WILSON, 1847

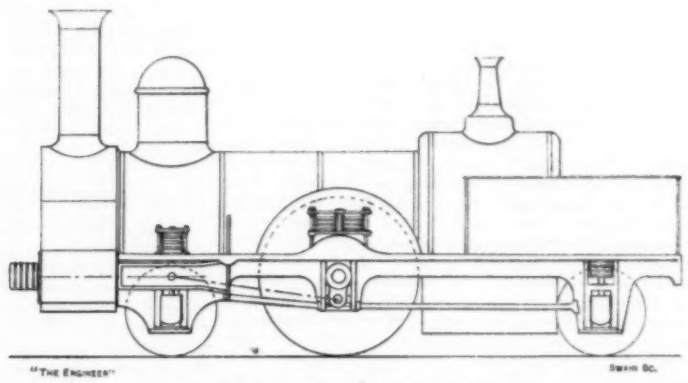


FIG. 67—McCONNELL'S L. AND N.W. ENGINE, 1849

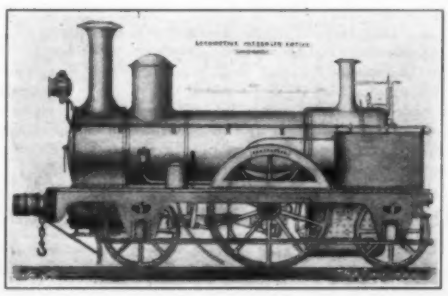


FIG. 68—T. HACKWORTH'S "SANSPAREIL," 1849

* No. X. appeared March 6th.

[1] The design is illustrated in "A Story of Railway Pioneers," by Major Snell, M.C.

[2] *The Times*, April 29th, 1847.

[3] For a full account with illustrations of the three-cylinder locomotive in both of the above forms see Warren, pag s 392–4 and 402. For drawings of the 2–2–2 type see D. K. Clark, "Railway Machinery," Plate 16.

which was oval in section, as low as possible. To this end the cylinder centres were 3ft. 9in. apart and the outside webs of the cranks were placed against the driving wheel bosses. The two inside bearings were between the cranks. The steam chests were hidden behind the outside frames, and to render the valves accessible were fitted with end instead of side covers.

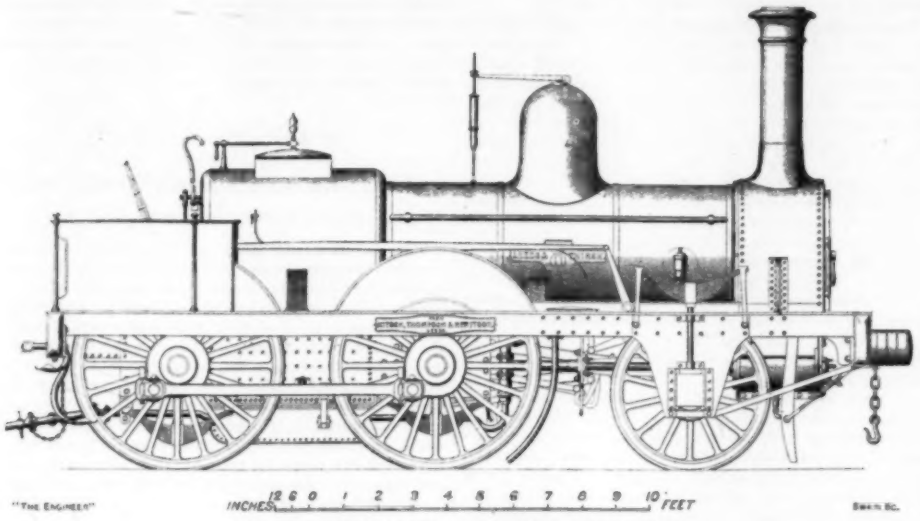


FIG. 69—KITSON'S LEEDS AND THIRSK ENGINE, 1849

The sides of the oval boiler were stayed across by thin plates in place of tie rods. The Plews started work in December, 1848, and Stephenson's engine in January, 1849.

Outside Cylinder Engines.—The development of this type was generally on the lines of the Crewe engine with mixed frames. Allan designed and built at Crewe in 1847 the Velocipede with 7ft. wheels and 15½in. by 20in. cylinders, but the largest engines of the type were to be found on the L. and S.W.R. One of these, designed by J. V. Gooch was built in 1848. The cylinders were 16in. by 22in. and the driving wheels 6ft. 6in. diameter. A number were built in 1849–50 with 7ft. driving wheels. They followed the general lines of the earlier engines of 1843 mentioned previously. Of the type with inside bearings for all wheels, similar to that on the Glasgow and Ayr and other Scotch railways, the Lancashire and Yorkshire standard passenger engine was illustrated in THE ENGINEER, February 2nd, 1923, p. 114. These were designed by Mr. Hurst under Sir John Hawkshaw's supervision.

One remarkable 2–2–2 express engine—Fig. 67—designed by McConnell and built at Wolverton in 1849, deserves mention. It was an extreme development of Forrester's "boxers," in which outside frames and driving bearings were combined with outside cylinders. The latter were 18in. diameter by 21in. stroke, and as a result of the frames being outside were spaced so far apart that they did not clear the structural gauge, so that some of the station platforms had to be altered. For this reason the engine was known as "Mac's Mangle." The driving wheels were 6ft. 6in. and the carrying wheels 3ft. 9in. diameter. The total wheel base was no less than 17ft. 2¾in., but to clear the cylinders the leading wheels were placed so far back that the weight at the front was excessive, and the large dome had subsequently to be moved from the front to the back ring of the barrel as a makeshift remedy. The boiler contained 189 2¼in. tubes and had a total heating surface of 1539 square feet, of which the fire-box with transverse partition provided 138 square feet. The total weight in working order was 31 tons 19½ cwt., of which the driving wheels carried 13 tons 19½ cwt. The springs throughout were formed of large india-rubber pads separated by metal discs, those for the driving bearings being double. This form of spring was frequently used by McConnell.

"Mac's Mangle" was the last British standard-gauge engine with outside cylinders and bearings, but the type became very common on Austrian and South German railways, on which it was developed by Maffei, Haswell, Kessler, and others.

Four Wheels Coupled Passenger Engines.—The majority of these engines were of the long boiler outside cylinder type, but in 1848–9 inside cylinder engines with the trailing axle behind the fire-box came into more extensive use. The type was derived from Stephenson's engine of 1837—Fig. 33 *ante*. Some four-coupled passenger engines by R. Stephenson and Co., 1848–9 for the York, Newcastle and Berwick Railway, had 6ft. coupled wheels and inside cylinders, 15½in. by 22in. The steam chests were outside and the excentrics were placed between the driving wheels and the outside frames. The driving tires were flangeless. Gothic fire-box casings, then dying out, were used on these engines.

In 1848 E. B. Wilson and Co. introduced the mixed-framed 2–4–0 engine with outside bearings for the leading wheels only. This was directly derived from the "Jenny Lind" type by substituting coupled wheels with inside bearings for the small carrying wheels of the latter. An engine of this class was illustrated in THE ENGINEER, October 15th, 1920, p. 371.

Six fine engines of this type—Fig. 69—were built in 1849 by Kitson, Thompson and Hewitson for the Leeds and Thirsk Railway, and for thirty years worked the fast passenger trains between Leeds and Hartlepool. They had 16in. by 22in. cylinders, 6ft. coupled wheels, wheel base 15ft. equally divided, and total heating surface 873 square feet, of which the fire-box provided 90 square feet. The boiler centre was 6ft. 2¾in. above rail level. Weight about 26 tons.

The plain welded sheet iron dome covers were a feature of Kitson's practice, introduced about 1848 from which the modern dome covers of to-day are direct derivatives. The reversing gear was arranged so that when the engine was in fore gear the reversing lever was at the back. This was a not uncommon design with several makers, but was a constant source of confusion to the drivers, and in later years the gear of many such engines had to be altered. Full particulars with drawings of these engines are contained in Clark's "Railway Machinery."

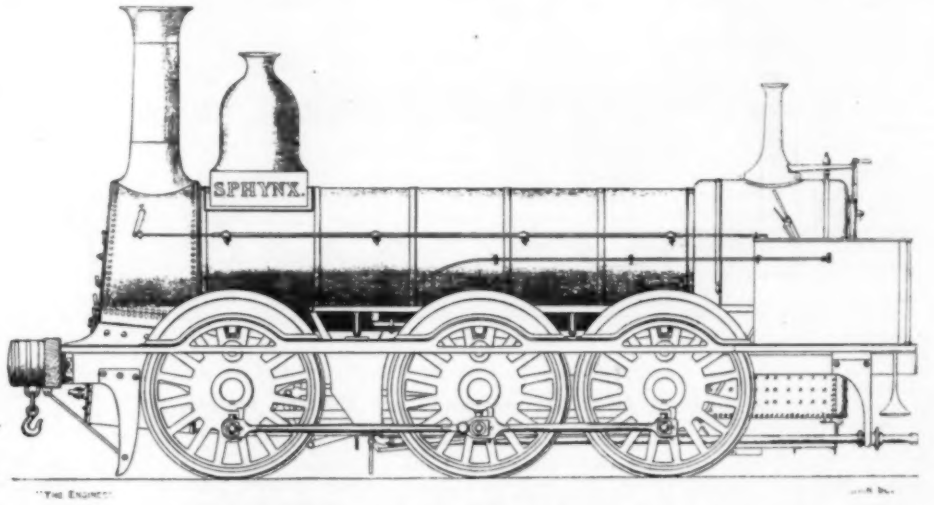


FIG. 70—SHARP BROTHERS' M.S. AND L. RAILWAY ENGINE, 1849

Goods Locomotives.—The most notable six wheels coupled goods engines of the period—Fig. 70—were built 1846–1849 by Sharp Bros. for the Manchester, Sheffield and Lincolnshire and the London and North-Western railways. They were of Stephenson's long boiler type of greatly increased power. The cylinders were inside, 18in. diameter by 24in. stroke, placed at 2ft. 3in. centres. The valves, which were underneath but inclined upwards towards the back, were actuated by direct link motion with valve rods suspended by long swing links from the bottom of the boiler. In these engines we now meet with the solid inside frame in one piece from front to back buffer beams with axle guards welded on. This was one of the greatest improvements of the period and is stated to have been due to Mr. Beyer, then head of the designing department of Messrs. Sharp. Messrs. Stephenson had welded axle guards on inside frames in 1832, but these were short frames extending between smoke-box and fire-box casing only—see Warren, pp. 280–281.

In the first engines of 1846 the coupled wheels were 4ft. 6in. diameter and the wheel base 11ft. 8in., but in the subsequent engines the wheels were enlarged to 5ft. and the wheel base lengthened to 6ft. 11in. + 5ft. 3in. = 12ft. 2in. The boiler had an inside diameter of 3ft. 8in. and contained 133 2¼in. brass tubes, 14ft. 3¾in. long. The fire-box had a transverse partition. Total heating surface 1148 square feet, grate area 10.6 square feet, weight in working order 26¼ tons.

The cast iron wheels had balance weights solid with the bosses. The boiler was rigidly secured to the motion plate, but at the back end was supported on the inside frame by means of the now usual form of expansion bracket.

Mr. McConnell adopted this design, almost in its entirety, for the main line goods engines of the Southern Division of the L. and N.W.R., for which line they were built until 1855 by a number of firms, but except those built by Sharp Bros., they had wrought iron wheels.

One of the early engines with 4ft. 6in. wheels was tested in 1846 between Longsight and Crewe with a trial train of 101 wagons weighing 597 tons, with which it covered the distance of about 28½ miles at an average speed of 13.7 miles per hour.

Charles Todd, who had left the Railway Foundry and started locomotive building in 1846 at the Sun Foundry, Leeds—now the works of Hathorn, Davey and Co.—built a number of goods engines with solid cast iron disc wheel centres. They ran on the York and North Midland and Great Northern railways. In addition to the defect of increasing the non-spring-borne weight, they were said to have rumbled noisily over the track.

What may be termed the standard British 0–6–0 goods engine with inside cylinders and frames and the trailing axle behind the fire-box appeared on the 4ft. 8½in. gauge for the first time in 1848, when Kitson, Thompson and Hewitson, of Leeds, and B. Hick, of Bolton, built the type simultaneously. Hick's engines were illustrated in THE ENGINEER, June 25th, 1920, but were not of such modern design as those of Kitson. Hick's engines had the old gab motion and were almost the last main line engines in this country to be fitted with it.

Kitson's engines for the Leeds and Thirsk and Midland railways—Fig. 71—had link motion. The

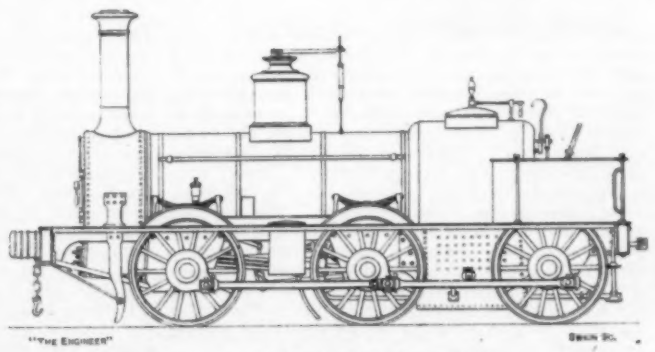


FIG. 71—KITSON AND CO'S ENGINE, 1848

cylinders were 17in. by 24in. and the wheels 4ft. 9in. diameter. Wheel base 15ft. 6in., equally divided. The boiler barrel, 11ft. long by 3ft. 8½in. diameter, contained 162 1¾in. tubes, the heating surface of which was 908 square feet. Total heating surface 1001 square feet. Their chief characteristic, which they had in common with the 2–4–0 express engines—Fig. 69—

was that the main frame plates at the trailing end were bolted on to the outside of the frame plates which extended from the front buffer beam to the fire-box casing, and themselves formed a portion of the latter. The lower portions of the side water spaces were therefore bounded by the fire-box copper plates inside and the frame plates on the outside, the stays being riveted over outside the latter. The joint between the front and back plates of the casing and the frame plates were made by angle irons. The arrangement provided a wide fire-box—3ft. 7½in. inside—with 3in. water spaces, but was objectionable in that no "breathing" was possible.

There was also in 1847–8 a revival of the 0–6–0 engine with outside frames and trailing wheels behind the fire-box, a type which had originated with Stephensons' Leicester and Swannington engine of 1834. Most of the new engines were built by R. Stephenson and Co. and E. B. Wilson in 1847–8. It is probable that the general design was due to Matthew Kirtley, of the Midland Railway, and both Stephenson's and Wilson's engines had the old clumsy arrangement of cylinders inclined upwards, and slide bars below the leading axle. Why this design was not discarded in favour of the much more mechanical arrangement used since 1843 in Stephenson's long boiler goods engines is a mystery, and the engines proved so troublesome in service that their average life did not exceed more than ten to twelve years. There were several similar engines by E. B. Wilson on the Great Northern Railway, which A. Sturrock reconstructed on orthodox lines.

Goods Engines with Outside Cylinders: Scottish Types.—The Caledonian and Scottish Central railways in 1847 adopted outside cylinders for goods engines, which were mostly of the 0–4–2 type originated by J. and G. Rennie in 1839—Fig. 36 *ante*. The general design was due to Robert Sinclair, and the first engines were built by Jones and Potts and the Vulcan Foundry. These had 16in. by 18in. horizontal cylinders, 4ft. 7in. coupled wheels, 3ft. 6in. trailing wheels, total heating surface 953 square feet, and grate area 14 square feet. A number of 0–6–0 goods engines were also built by Jones and Potts for the Caledonian Railway with outside cylinders, 17in. by 24in., but the latter type never established a footing on British railways. Mr. Sinclair subsequently converted them to 0–4–2 engines, at the same time reducing the cylinders to 17in. by 20in. Particulars of C.R. Nos. 124 to 127 in their original condition with six-coupled wheels are given on pages 130–1, and a diagram No. 35 on plate VI., Part 2, of Clark's "Railway Machinery."

Passenger Tank Engines.—Tank engines for local traffic, of which there had been only a few early examples by Forrester on the Dublin and Kingstown and the London and Greenwich Railways, again appeared in Ireland in 1846, when the Vulcan Foundry supplied three side tank engines of very unusual design—Fig. 72. The engines had very deep and long side tanks, and to distribute the weight four axles were provided. The cylinders, 14in. by 20in., were inside, and the third pair of wheels, 5ft. 6in. diameter, with T iron spokes, were the drivers. The carrying wheels, 3ft. 6in. diameter, had V bar spokes. The wheel base, 15ft. 10in., was rigid. These were the earliest *side* tank engines, and their existence disposes of a claim which has frequently been made on behalf of Crewe works to priority of this type. The driver was apparently expected to oil the motion by getting underneath the engine.

In 1847 Sharp Brothers built two outside cylinder engines with single driving wheels for the Manchester and Birmingham Railway, for service on the Macclesfield branch. The horizontal cylinders were 15in. by 20in., thedriving wheels 5ft. 6in. diameter, and the pressure 120 lb. One tank was underneath the boiler, between the leading and driving wheels, and the other underneath the coke bunker at the back. Their total capacity was 480 gallons. The frames extended from the front to the back buffer beam, and all wheels had inside bearings only. Brake blocks were placed at the back of the driving and in front of the trailing wheels, and were actuated by a vertical screw and toggle joint. The wrought iron driving wheels had balance weights in the rims. These were formed of cast iron blocks held in place by wrought iron plates, and balanced the revolving masses only. These engines, with their details, were fully described and illustrated in Tredgold's "Steam Engine."

The London and Blackwall Railway tank engines, by Jones and Potts in 1848, were of the outside cylinder type, with 5ft. 6in. single driving wheels. The inclined cylinders were originally 13½in. by 18in., but were subsequently enlarged to 14in. by 20in. These engines were of Allan's Crewe type, with outside bearings for the carrying wheels, but the tanks were placed underneath the trailing end. Their total weight was slightly over 22 tons.

Steam Motor Coaches.—Steam carriages for branch lines were introduced in 1847 by W. Bridges Adams, though the idea of the first one appears to have been due to Mr. Samuel, engineer of the Eastern Counties Railway. This was an inspection engine, which with open carriage, tanks, and vertical boiler on the same frame, ran on four wheels. An illustration appeared in Colburn's "Railway Machinery," page 75, and more complete drawings in Tredgold's "Steam Engine" (1850 ed).

In 1848 Mr. Adams built at his works at Bow a larger combined motor coach for the Bristol and Exeter Railway (7ft. gauge). This engine, the "Fairfield," had single driving wheels, 4ft. 6in. diameter, in front, which were driven through a dummy crank shaft, actuated by inside cylinders, 7in. by 12in. The shaft was connected to the driving wheels by outside coupling-rods. The boiler was of the vertical type. The engine and carriage were on the same frame.

In the "Enfield," built in January, 1849, for the Eastern Counties Railway, the engine was of the 2–2–0 outside cylinder type, and the carriage also ran on four wheels, the whole being combined on one frame. This arrangement produced a vehicle with very long wheel base, and to accommodate the curves, only the leading engine wheels and trailing carriage wheels had flanges. The cylinders were 8in. by 12in., and the driving wheels 5ft. diameter. The boiler, which was of the ordinary locomotive type, had a total heating surface of 255 square feet and carried 120 lb. pressure.

The long combined engine and coach was found to be inconvenient in service, and subsequently they were separated. Later, in 1849, Mr. Adams built the "Cambridge" for the Eastern Counties Railway. This was an independent 2–2–0 engine, to which one or two light carriages could be attached in the ordinary way. This type of light engine, of which an illustration appears in Colburn, page 75, was frequently used in Ireland, for the railways of which Messrs. Stephenson and Kitson built a number. The outside cylinders were placed behind the leading wheels, and the single driving wheels were in front of the fire-box. The tanks were carried beneath the boiler, and to produce a steady engine the wheel base was of considerable length. One of Stephenson's engines for the Londonderry and Enniskillen Railway, with 11in. by 18in. cylinders, 5ft. driving wheels and 10ft. 4in. wheel base, was illustrated in Clark's "Railway Machinery," plate 28.

"History repeats itself." When motor coach engines were reintroduced in this country in 1903–7, the types passed through similar combined and separated types, and then, with a few exceptions, died out just as rapidly.

Miscellaneous Locomotives.—The briefest mention may be made of Crampton's patent locomotive, "Lablache," built by E. B. Wilson in 1847, which ran upon four 6ft. wheels, driven by means of an intermediate oscillating shaft. There is no necessity to describe it here. Those interested will find fuller particulars and illustrations in The Engineer, March 12th, 1880, page 191. Also see Colburn—page 79—who gives the wheels as 6ft. 6in. A drawing dated March, 1848, shows 6ft,

Another "freak" engine, the Albion, was illustrated in The Engineer, February 5th, 1897. This was a six-wheeled engine, of which the two leading pairs were driving wheels. They were driven by intermediate oscillating shafts, but the chief feature was a transverse cylinder with vibrating vane pistons, the rods of which issued laterally and formed the driving shafts. The engine was built in 1848 by Thwaites Brothers, of Bradford, and ran for a time on the old South Yorkshire Railway.

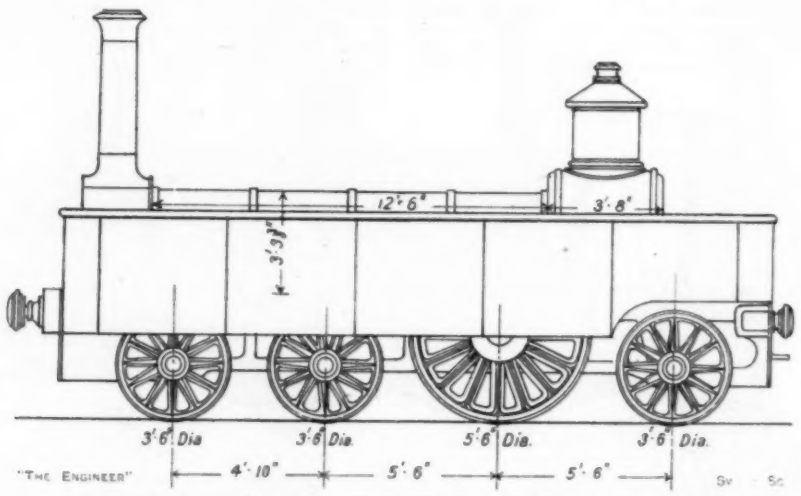


FIG. 72—VULCAN ENGINE FOR WATERFORD AND KILKENNY RAILWAY, 1846

Indian Monsoons and Floods in 1924.

By REGINALD RYVES, M. Cons. E., Assoc. M. Inst. C.E.

The information here given is derived from the monthly supplements to the Indian daily weather reports for the part of the year including both monsoons. Engineers who are specially interested in rainfall records may find this summary convenient for reference, and the brief notes relating to floods may serve to indicate the nature and extent of those which occurred during the year, and their distribution throughout India. The rainfall records are also briefly reviewed. So many serious floods occurred, some of them probably exceeding previous records, that it is desirable to present, in a form not too condensed, a summary which will indicate the nature and distribution of the rains which produced them.

General Character of the Monsoons of 1924.

In June the monsoon was unusually weak in all inland divisions. The Bay monsoon, restricted to Burma till the 6th, had reached the west of the United Provinces by the end of the month. The Arabian Sea monsoon appeared on the Malabar coast on the 2nd, but developed slowly, and monsoon conditions were not established in the Deccan and the Central Provinces till about the end of the month. Rainfall was nearly normal in Burma and North-East India, half the usual amount in Bihar and Orissa, a fourth in the United Provinces, and elsewhere in large deficiency, except in South Madras, the Konkan, and Gujerat. Both branches of the monsoon strengthened during July, causing fairly copious rains over most of the Indian area, but from the 12th to the 21st the Arabian Sea current was weak over most of its usual field, being directed almost wholly to Malabar and the neighbouring ghats, the rains causing serious and extensive floods in South India. After the 21st it extended northwards and rains were fairly general, except in South Madras, with locally heavy rain in North-West India. The August rainfall was normal as a whole, and nearly normal in most of the main divisions. During the first twelve days of the month the Bay monsoon was fairly vigorous over most of its field, but the Arabian Sea monsoon gave rains unequally, being influenced by a depression which travelled across the head of the Peninsular. Widespread and locally heavy rain fell in Orissa, the Central Provinces, the United Provinces, Central India, and East Rajputana. A short break, from the 16th to the 18th, was followed by normal conditions, a depression which travelled westward from Arakan to Baluchistan causing widespread rain in the Peninsular, the central parts of the country and North-West India. In September the Arabian Sea monsoon was much more active than the Bay current. The month's rainfall was below normal only in the Konkan, Orissa and Burma; it was in excess over the rest of the country, especially in North-West India, and the adjacent parts of the United Provinces and Central India. A depression passed from the north Madras coast to the east United Provinces between the 3rd and 10th. Another crossed the Madras coast on the 25th and traversed the Deccan to Gujerat, east Rajputana and the Simla-Kumaon hills, causing widespread and locally heavy rains in the neighbourhood of its track. The total monsoon rainfall for the period June to September was nearly normal over the greater part of the country; it was in considerable excess in the West United Provinces, the North-West Frontier Province, Rajputana and Malabar, and was appreciably deficient only in Orissa and Kashmir. Over the plains of India as a whole the rainfall was 3in., or 8 per cent. above normal. In October, South-West Monsoon conditions prevailed in the middle of the Bay of Bengal, causing rainfall in some excess of the normal in Burma and abnormally heavy rainfall from North Hyderabad to the West United Provinces and the South-East Punjab. The establishment of North-East Monsoon conditions was delayed, resulting in a large defect in the rainfall of Madras and Mysore. On the 11th a depression crossed the coast of Orissa and passed over the Central Provinces and Central India West, causing heavy rain. Later, a small depression brought local rains to North-East India, and heavy rain fell in Arakan, Akyab reporting 13in. in the twenty-four hours, 19th–20th. The depression disappeared on the 21st, and the conditions changed to those typical of the North-East Monsoon, the rainfall in Madras increasing from the 24th to the 27th. The month's rainfall was more than twice the normal in the United Provinces West Rajputana, Central India

West, Berar, and the Central Provinces West. It was in moderate to large excess in Lower Burma, the Central Provinces East, and Hyderabad North. The average over the plains of India was normal, but no rain fell in the Punjab South-West, the North-West Frontier Province, Baluchistan, Sind, and Rajputana West. In November the North-East Monsoon strengthened till the 10th. A cyclonic storm passed inland near Gopalpur on the 19th, after causing heavy weather at sea, and extending northwards, brought unusually wet weather to Orissa, Bengal, and Assam. The monsoon then weakened, and was diverted towards South Burma, North Burma, the north of the Peninsular, and North-East India successively. Averaged over the whole country, the rainfall was 50 per cent. in excess, though there was a deficiency in some divisions. In Orissa four times the average of 1.81in. was recorded.

The Season's and Months' Rainfalls.

For the period of the North-West Monsoon, June to September inclusive, there was not, in any of the fifteen divisions, a defect of more than 12 per cent. (Hyderabad), smaller defects being recorded in the Central Provinces, Bihar, Orissa, and Bombay. In the remaining divisions there were excesses, important in three only—Madras, 33 per cent.; North-West Frontier Province, 52 per cent.; and Rajputana, 66 per cent. Classification by subdivisions, of which there are thirty-three, showed defects of over 23 per cent. in Kashmir, the Bay Islands and Orissa; and excesses of 33 per cent. in the United Provinces East; 76 per cent. in Rajputana East; and 58 per cent. in Malabar, where the rainfall for the four months was 117in.

Month's rainfalls, for whole divisions, and 40 per cent. or more in defect were:—Bombay, 53 per cent. in October, the average being only 2.28in.; Mysore, 67 per cent. in October, average 1.84in.; and similar large percentage defects from very small averages. In excess by 40 per cent. or more, not counting cases in which the month's average is less than 5in.:—Rajputana, 58 per cent. in July and 249 per cent. in September; Central India, 56 per cent. in July and 43 per cent. in September; Madras, 54 per cent. in July and 57 per cent. in September; United Provinces, 121 per cent. in September (38 per cent. in July); Rajputana, 58 per cent. in July and 249 per cent. in September; Bihar and Orissa, 533 per cent. in September (average 5.38in.). Classification by subdivisions showed in defect:—Orissa, 41 per cent.; Sind, 53 per cent.; and Hyderabad, 42 per cent. in July; and the Bay Islands, 45 per cent. in September. In excess:—The United Provinces East, 49; and Central India East, 77 per cent. in July; Malabar, 86 in July, 66 in August, and 41 in September; Rajputana East, 52 in August and 236 in September; Berar, 56 in August and 167 in October (average 5.09in.); Bombay Deccan, 43 in August; Chota Nagpur, 49 in September; United Provinces West, 204; the Punjab East and North, 111; Rajputana West, 294; Gujerat, 42; Central India West, 54; and Madras Coast North, 96 per cent., all in September; Central Provinces East, 42 in September and 79 in October (average 5.05in.); Lower Burma, 51 in October; and the Bay Islands, 57 per cent. in November.

Heavy Storm Rainfalls.

In July, between the 16th and 23rd, 35in. fell at Calicut and 27in. at Cochin; at Mercara, a hill station, 63in. fell in the days 14th to 24th, the heaviest fall in twenty-four hours being 14.35in. This heavy rain caused widespread floods in Southern India. Many bridges were washed away or damaged beyond repair, a vast expanse of country was flooded, and thousands of people were rendered homeless. In August a depression crossed the coast near Balasore and moved north-west. Day's rainfalls of 3½in. to 4½in. were recorded at Balasore, Bukitala, and Sambaipur. On the 25th there were rainfalls of 4in. at Parbhani, 5in. at Nizambad, and 7in. at Hanamkonda, and in forty-eight hours Deesa received 10in. and the hill station of Mount Abu 23in. During the month there were floods in various parts of the country—notably the Madras floods and those in Malabar and in the region of the Upper Ganges Canal. Heavy rains in Rajputana caused floods and breaches in railway lines.

In September there were heavy rains in Rajputana, from the 9th to the 11th. Ajmer, Jaipur and Jodhpur received 12in., 8in. and 9in. respectively during this period, and some other stations reported falls exceeding 5in. in twenty-four hours. There were serious floods which extended later to the Agra district, and caused much damage to property and some loss of life. The cyclone which disappeared in the Simla-Kumaon Hills on the 30th caused heavy and continuous rain. Between the 27th and 30th Meerut recorded 18in., Delhi 8in., Roorkee 20in., Ambala 13in., Mussooree 24in., Mukteswar 17in., Dehra Dun 20in., and Simla 12in. There were many breaches in the railway lines in the South-East Punjab and the West United Provinces. Another storm, which affected Central India West and the west of the United Provinces in October, caused heavy rain; Khandwa recording 5.77in. on the 12th, and Jaipur and Meerut 4.50in. and 3.56in. respectively on the 13th. In this month there was heavy rain in Arakan (Lower Burma), including a fall of 13in. in twenty-four hours at Akyab.

In November there was very wet weather from the 16th to the 19th in Orissa, Bengal and Assam, Gopalpur recording 11in. and Puri 13in. in the four days. The railway line between Palasa and Berhampore was flooded.

Heavy Falls in Twenty-four Hours.

The intensity of rainfall for short periods, such as an hour, or two or three hours, is often very great in the Tropics, and such heavy showers occur more frequently than in Europe, for instance. Very heavy day's rainfalls are also more frequent in India than in Europe, but not to the extent sometimes supposed, and the twenty-four-hour rainfalls of the plains and the smaller hill ranges are not of a different order from those experienced in the temperate zones. This is well shown by the Indian rainfall records for 1924, a year favouring the occurrence of heavy local falls. Not only was the rainfall of the South-West Monsoon 8 per cent. above the normal, but the 1924 average for India as a whole included very scanty rainfalls in some divisions during a part of the period, the rains being diverted to other areas where large excesses were recorded. There was also some concentration in time, for the June rainfall was in defect generally, the July rainfall 23 per cent. in excess, and that of November 59 per cent. in excess.

Several large and active depressions traversed considerable areas of the country and caused widespread and severe floods. We may, therefore, regard the year as one in which the number of heavy 24-hour falls might be expected to be large. From an inspection of the records of July to November, in which we find for every month and for 182 stations the heaviest 24-hour rainfall, we find that in only 111 out of the 910 cases—station months, not station days—were falls of more than 4in. in 24 hours exceeded; in July 38 cases, in August 34, in September 30, in October 5, and in November 4. Out of these 111 cases there were 43 in which the maximum fall of the month exceeded 6in. in 24 hours; in July 14, in August 8, in September 17, in October 2, and in November 2. Cases—station months—of rainfalls which once or several times exceeded 9in. comprised only ten; two in July, three in August, three in September, and two in October. Of these maximum 24-hour falls, for the station month in each case, one was at Diamond Island, one in Lower Burma, seven at hill stations, and only one in the plains, in Central India. The subdivisions in which the maximum 24-hour fall in a month exceeded 6in. were: Assam; the United Provinces East; the Punjab South-West; Rajputana West, 8.5in.; Central India East, 9.6in.; Madras Coast North; twice in the Punjab East and North; in Konhan, and in Hyderabad South; thrice in Bengal and Malabar; five times in the United Provinces West; eight times in Lower Burma; and ten times at hill stations. Of the maximum falls of the ten station months for which 24-hour falls of 9in. were exceeded, seven were at hill stations, Cheerapunji, 16.26, 13.46, and 9.84; Mount Abu, 12.85 and 10.20; Mercara, 14.35; Mussooree, 10.22. One was at Diamond Island, 9.1; one at Akyab in Lower Burma, 13.04; and one at Sutna, Central India East, 9.6. A few falls of between 8in. and 9in. were also recorded.

In the large area included in India and Burma the heaviest 24-hour fall of a month only exceeded 6in. at 35 of the 182 stations, and 9in. at only seven stations. A fall of about 9in. in 24 hours seems to be what may be called the "normal maximum" of a great rainstorm, while 13in. may perhaps be regarded as the exceptional maximum, usually occurring on the coast, the general situation being regarded apart from the special case of a range of mountains which deflects upwards a strong damp current. We have had in England in recent years one storm for which a 24 hours fall of over 8in. was recorded, this applying to 18 square miles, and one for which the maximum was just over 9in. As regards the tropics there may perhaps be more uniformity than is usually supposed in the intensity of very heavy rainstorms due to the passing of large and active depressions, for it must often happen that the path of the storm centre, during its period of maximum activity, does not pass over a rain-recording station.

Possibly a large proportion of the great rainstorms have a maximum intensity corresponding to 9in. in 24 hours, a smaller figure being recorded because no station is being traversed, for the whole period of that activity, by the centre line of the storm. Even if the centre of the storm traverses a continuous chain of stations it may cause at each of them a rainfall much smaller than that which a rain gauge travelling with the storm would record. A slowly moving storm yields records which are high in relation to its intensity and compared with those of a swiftly moving storm. In other cases the centre line of the storm may pass entirely between two stations during the period of greatest activity, as occurred some years ago in the case of a cyclone which did great damage at Karachi, and then disappeared as far as rain-recording stations were concerned. It passed some days later between the stations at Sialkot and Rawalpindi, which are 58 miles apart and some 800 miles inland from Karachi, but these places recorded rainstorms of no more than ordinary intensity. It happened, however, that an engineer of the Irrigation Department was burning bricks for the Triple Canal project at Jhelum, which is about halfway between those two stations, and many of his kilns were destroyed by a deluge of rain evidently due to the passage of the Karachi storm.

The floods of 1924 will long be remembered in India. An engineer, who has been much concerned in official capacities with Indian rivers, cannot recollect in his forty years of experience a year of so many great floods, those of Madras and of Northern India being likely to prove to have been the greatest of which we have records. Unfortunately, the engineers are likely to be so busy repairing the damage done that they will not have leisure to collect the data, though this should be of wide interest. It is to be hoped that the Indian P.W.D. and meteorological departments will co-operate to bring out a joint memoir on these floods when they have collected the data.

Improvement of the Rhine to Rhone Canal.

The canal connecting the Rhine with the Rhone by way of the canalised Saône starts from Strasburg and runs alongside the Rhine upstream to Mulhouse, where there is a short branch to Basle. Thence it turns south-westward and, passing through Besançon and Dole, joins the Saône at Saint Jean de Losne, the total length being 350 kiloms., or 218 miles. Until 1919 its different reaches were of various depths, the maximum being 1.4 m., or 4.6ft., and the locks were of various dimensions, the smallest imposing a limit of about 120 tons displacement for barges traversing the whole length of the canal. There was not much traffic and most of it was local.

An account of the improvements begun in 1919 and now successfully completed is given in *Le Génie Civil* of February 14th, and the description of the pumping arrangements, here only briefly outlined, is worth the attention of hydraulic engineers. The improvements now effected have made the canal navigable by barges of 300 tons displacement, and especially facilitate the importation of coal from the Ruhr and the Sarre. The canal is now of a uniform depth of 2.20 m., or 7.2ft., with a bottom width of 10.50 m., 34.4ft. The locks are 40.5 m. by 5.3 m., 133ft. by 17.4ft.

A portion of the canal about 6 kiloms. in length, on the Rhone side of the watershed, is insufficiently supplied with water to make up for absorption and lockage, and it was decided that water should be pumped from the plentifully supplied reach at the downstream end of this portion of the canal, the pumping being done in stages by separate plants, one at each lock. The total deficit to be made up is normally 11,000 cubic metres per twenty-four hours. In the calculation of the water used in passing barges up and down the displacement of a barge going up is a loss and that of a barge coming down is a gain. In this case the tonnage of the Rhine to Rhone traffic is by much the greater, a factor reducing the quantity of water to be pumped. A barge which displaces 300 metric tons when fully laden is reckoned to have a displacement of only 30 tons when empty, so that a credit amount of 1620 cubic metres results from passing six empty barges up and six fully laden barges down.

The full quantities of water which will have to be pumped in periods of drought at locks 6–5 to 2–1 are:—11,083, 11,051, 10,798, 5599, and 4800 cubic metres.

The pumps are driven by electric motors and, in order to obtain the cheapest rate for the current, 0.20f. per kilowatt-hour, the pumping is done in eight hours, from 9 p.m. to 5 a.m. The current is taken at 9000 volts from a line which runs nearly parallel to the canal and is transformed to 220 volts at each of the locks. The pumps are centrifugal, of a type specially chosen to suit the small lifts, the greatest of which is 3.38 m., or 11.1ft., and they have an efficiency of 80 per cent. The overall efficiency, which was calculated as 58 per cent., has been found by trials to range between 55 and 61 per cent., and these figures are compared with the efficiency of 43 per cent. in the case of the Bourgogne canal plant installed in 1897. The cost of current for passing a fully laden barge upstream is about 2.7f. at the lock with the highest lift. The working of the pumping plants is, as far as possible, automatic, and is in the hands of the lock-keepers, one of whom, being specially instructed, assists at each lock in turn.

LIVERPOOL ENGINEERING SOCIETY.

A paper was read before the members of the Liverpool Engineering Society on Wednesday, the 4th inst., by Mr. E. Astbury, A.M.I. Mech. E., on "The Construction of a Spirally Guided Gasholder and Tank at Garston," the finished dimensions of which are 152ft. 6in. inside diameter and 36ft. deep, measured from the bottom of the tank to the top of the concrete coping. The holder is telescopic, and consists of four lifts, which are spirally guided. The inner lift is 142ft. 4in. diameter, 34ft. 6in. deep, and has eighteen guide rails; the second lift is 145ft. 0½in. diameter, 34ft. 4in. deep, and has twenty-four guide rails; the third lift is 147ft. 9½in. diameter, 34ft. 4in. deep, and has thirty-six guide rails; and the outer lift is 150ft. 6½in. diameter, 34ft. 4in. deep, and has forty-eight guide rails. The total height of the holder when fully inflated is 140ft. above the top of the tank coping. The sheeting of the holder, both for the crown and sides, is mainly ½in. plates, excepting the rows next to those of the curbs, cups and grips, which are ⅜in. thick. The plates and rivets used are of wrought iron throughout. The iron is specified to be of the best quality and to stand a tensile strain of 21 tons per square inch, with a contraction of original area at fracture of 18 per cent. with the fibre, and 18 tons and 8 per cent. across the fibre. The holder is designed with a factor of safety of 4, to withstand a wind pressure of 40 lb. per square foot, and the total weight of the bell is 612 tons.

Wire Chain Making.

No. II.*

Of the other two types of chain mentioned in the previous article, the manufacture of jack chain involves the employment of comparatively simple machinery; but the machines used for making knotted chain are ingenious in the extreme. Both forms of chain, besides a variety of others with which we are not concerned at the moment, are made by the Aston Chain and Hook Company, Limited, of Bromford-lane, Erdington, Birmingham, and the following notes are based on the practice at that factory.

Jack chain is, of course, of that form in which each link comprises two circular loops set in planes at right angles to one another, and is used for a variety of purposes for which no great tensile strength is required. The strength is, however, materially increased by folding each link back on itself, so that one of the loops is duplicated and "Double Jack" chain is produced. The process of making both varieties is very similar.

The wire is fed into the machine transversely, and is cut off in the usual manner. A vertical peg carried by a horizontal slide then pushes the wire between two dies and forms a U. In the case of double jack chain, both the limbs of the U are of equal length, but for single chain one is shorter than the other. The dies then close together in a horizontal plane and bend the wire round the back of the peg, so that a complete circle is formed with a tang projecting. The tang is either double or single strand, according to the type of chain being made. At this point a horizontal mandrel moves forward over the top of the tang, and takes a stroke downward, which starts to form the second loop of the link. A tool moving forward from the back, and another coming down from above, complete the folding of the wire round the mandrel, and as soon as the mandrel has been retracted, the wire for the next link is projected through that just completed. It will be appreciated that the shape of the links obviates any trouble through the chain being twisted and kinked in manufacture, as each link is formed in a position appropriate for the reception of the next one in sequence. The result is that the finished chain can be led straight away to a tub or any other handy receptacle.

The machine used for making knotted chain—see Fig. 6—is a far more complicated affair, and although it would require an inordinate amount of space to describe its mechanism in detail, it may be of interest to indicate the general principles of its action. It is noteworthy, incidentally, that while more than one claim has been made for the origination of the design of the knotted chain machine, there are minor variations in almost every factory employing them, and the general practice is for the users to make their own machines.

The chief characteristic of the knotted link chain is, of course, the fact that in one operation, and without any welding or soldering, a chain is produced, which has practically 100 per cent. of the strength of the wire from which it is made. On the other hand, the chain is not very flexible, as the length of the links cannot be reduced to the same limits as with other types of chain. It has, however, a large variety of applications and has the great merit of cheapness.

One of the peculiarities of the machines used to make these chains is that most of the movements are of considerable extent, and consequently they are actuated by cranks, instead of cams, as is the case with round link chains. It is not, however, necessary to describe these parts of the machine, and we go on directly to explain the operations it performs, with the assistance of the engraving, Fig. 6, and the diagrammatic sketch, Fig. 7.

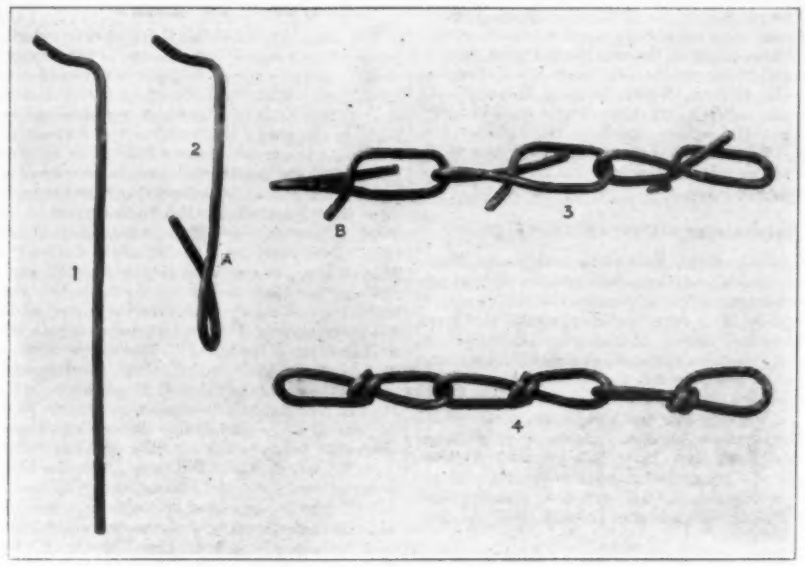


FIG. 6—FOUR STAGES IN THE MANUFACTURE OF KNOTTED CHAIN

The wire is taken off a spool at the back of the machine, and is fed forward by a reciprocating slide. In view of the facts that a considerable length of wire has to be supplied for each link—some 5in. for a link 1¼in. long—and that it must be delivered quickly, in order not to delay the other operations, the feed has a very powerful grip on the wire. This grip is effected somewhat as indicated in Fig. 8. In the feed slide there is pivoted a horizontal lever, beneath the front end of which the wire runs. Under the rear end of this lever there is a wedge. The wedge and the frame carrying the lever are free to slide on one another through a short distance. At the back end of the feed stroke the slide runs under a leaf spring, which checks it, on starting the forward stroke, just sufficiently to make the lever ride up the wedge and grip the wire. The pull of the feed on the wire then tends to accentuate the grip. In order to prevent the wire running back on the return stroke, it is passed through a split die—as indicated in Fig. 8. The inlet side of this die has a rounded corner, while the opposite edge is sharp and square, so that it bites the wire and holds it from being drawn back. On the return stroke, the relative movement of the gripping lever and the wedge releases the wire.

After passing through the die the wire is led through a tapered spout, which is pivoted at the rear end—as shown in Fig. 7. This spout guides the wire in front of the cut-off tool, and swings back with it as it is sheared off. The wire is shot right across the machine, and is caught at the front in a V-shaped guide, which ensures that it has passed over a little anvil projecting from the frame of the machine.

The cut-off slide now moves forward, bringing with it a bending tool, which forms the wire, against the back of the fixed cutter, into the shape shown at 1 in Fig. 6. As soon as the wire is over the top of the anvil, which is shaped much like the blunt end of an almond, a gripper comes down on the top and holds it tight. (This gripper is not shown in the diagram.) The next operation is the bending of the first loop of the link, and this is effected by a hollow twister, driven by a rack and pinion—as indicated in Fig. 2. The end of the twister has a projecting beak, which catches the wire and twists it downwards round the anvil—as shown at 2 in Fig. 6. At the same time, another slight projection produces the faint kink in the shank of the wire seen at A.

The main slide now moves to the right and forces the bending peg—see Fig. 7—against the straight part of the wire, where it bridges the gap between the fixed tool and the tumbler. The wire is thus doubled up and takes the form shown at 3 in Fig. 6, with the two ends overlapping one another. The tumbler must now be dropped, so that the projecting end B of the new link may be cleared as the chain moves on to the right. This action is effected by a slope on the main slide riding under the tumbler, which is pivoted to the frame. In machines working on large wire this

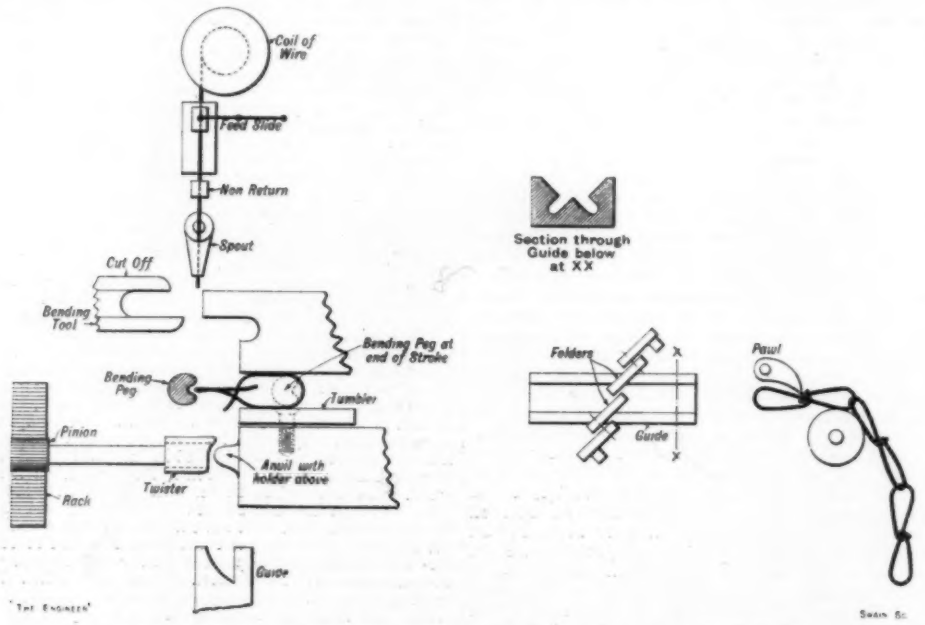


FIG. 7—DIAGRAM ILLUSTRATING ACTION OF KNOTTED CHAIN MAKING MACHINE

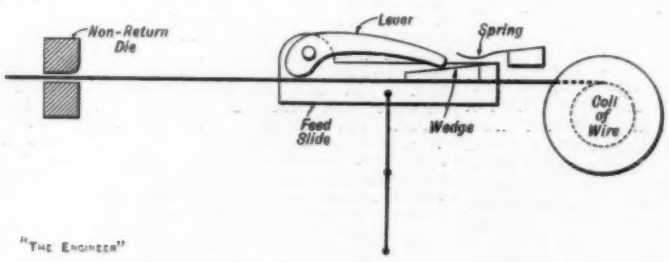


FIG. 8—FEED GEAR

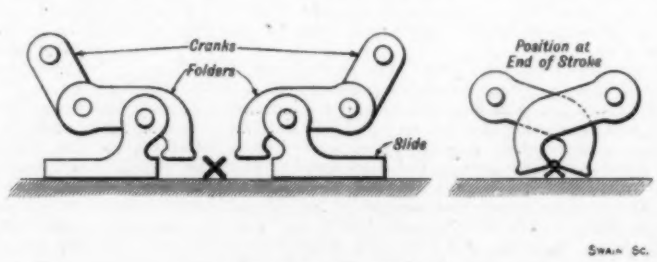


FIG. 9—FOLDING TOOLS

* No. I. appeared March 6th.

tumbler needs careful attention, as it has to take the heavy end pressure produced in bending the wire, but must at the same time be free to swing on its pivot.

The links are drawn forward, as they are made, by a pawl on the extreme right of the machine—see Fig. 7—which works with the main slide and keeps the chain in tension. The links then run into a guide which has a section, as shown in detail in Fig. 7, that securely grips the lower limbs of the link. It will be noticed in Fig. 6 that the chain is twisted through an angle of 45 deg. between the bending tools and the guide, so that the links go through the guide with the two projecting ends uppermost. The final operation is the folding over of these two ends to form the knot at the centre of the link—as shown at 4 in Fig. 6.

This operation is effected by two rocking tools that slide in ways set diagonally across the machine, and while it is in progress the link is held by two pressers which push it down firmly into the guide. The action of the folders is indicated in the sketch, Fig. 9, which shows that they are pivoted in sliding blocks and, at their rear ends, are connected with cranks that are given an oscillating motion by powerful toggle levers. The result is that during the first part of the stroke the nose of the folder rises slightly and pushes the end of the wire over the shank. At the end of the stroke the crank is rising and the nose of the tool is consequently depressed, so that the end is folded tight round the shank. Both the ends are, of course, folded simultaneously, and it takes some skill on the part of the tool maker to arrange the folders so that they will not foul one another in passing. The strength of the chain naturally depends on the security of the knots made by the folders, and it is rather surprising how tightly these folds are made, a fact which can be tested by cutting one of the links at the end, when, in a well-made chain, it will be found that the two parts still hold together quite firmly.

After the folding operation the chain is complete and is collected in any convenient manner, but it is generally treated in a tumbling barrel to remove any roughness which may have been left by the tools, and is sometimes galvanised or lacquered.

At the works of the Aston Company chain of this type is made in a variety of sizes ranging from No. 2 to No. 18 gauge.

The Inner Structure of Alloys.

IN a series of three Cantor Lectures at the Royal Society of Arts, delivered on February 16th, February 23rd, and March 2nd, Dr. W. Rosenhain, F.R.S., dealt with the atomic structure of metals and alloys. He began by describing, with the aid of diagrams and photo-micrographs, the various constituents found in metals and alloys and the manner in which they are formed. Particular attention was given to the formation of solid solutions and to their properties, since most of the constituents of alloys are of that nature. Dealing with the great mass of facts about metals and alloys which had been gathered by the scientific researches of the last sixty years, and by the long-continued observations of practical men for many centuries before that, the lecturer suggested that they constituted an unconnected maze and that it was only the new insight into the atomic structure of matter which had been provided by means of X-ray analysis of crystals that offered the prospect of discovering the systematic connection between all these facts.

After describing in very brief outline the methods by which X-ray analysis revealed the arrangement of the atoms in a crystal, the lecturer dealt with the structures found in pure metals, devoting some time to the explanation of the nature of a space-lattice and to the individual characters of the face-centred cubic, the body-centred cubic, and the close-packed hexagonal lattices so frequently found in metals.

In his second lecture Dr. Rosenhain explained the fundamental ideas of his theory of the structure of solid solutions. The first step is the recognition that when a metal (B) exists in solid solution in another metal (A) the resulting crystals are formed with the same lattice structure as (A)—in the case of fairly dilute solid solutions, at all events—and that the necessary number of atoms of (B) are substituted for atoms of (A) on that lattice. The first proof of the truth of this view, obtained by Owen and Preston, was cited, and the lecturer was able to state that at the present time the "substitution" hypothesis had been established for the great majority of solid solutions. The one important exception appeared to be the solution of carbon in gamma iron, where Westgren has shown that the carbon atoms are placed interstitially between the iron atoms, probably attached to certain of them by some form of chemical union.

The next step in the argument was that when an atom of metal (B) replaced an atom of (A) on the lattice a certain amount of distortion of the lattice must result, not so much because the stranger atom was of different "size" from the parent atoms, but because the forces which it exerted on its neighbours —its "field of force"—would be different. An atom having a weak force-field, therefore, might allow the lattice to expand, either locally or generally, although the atom itself might be "small," and *vice versâ*. In this respect Dr. Rosenhain's ideas differ widely from some older views in which the atomic volume of the dissolved metal was regarded as the only vital factor. A further step in the lecturer's argument was based on the conception that there is a limiting degree of distortion which a given lattice will withstand; when inter-atomic distances in such a lattice are stretched beyond a certain limiting value the atoms can no longer retain their cohesive connection and the lattice breaks down, with the formation of a new phase, which may be either another lattice or an amorphous phase, either liquid or "solid." The amount of distortion which a lattice could bear was, however, a question of energy content. Distortion of a lattice implied energy storage, and when an alternative condition having a lower energy content was possible the distorted lattice would break down and the alternative phase would be formed. The limiting degree of lattice distortion, therefore, depended upon the energy content of the alternative phase and was not an absolute constant for a given lattice. An important difference would also arise between "hard" or stiff lattices, in which distortion took the form of a general widening-out of the lattice spacing, and "soft" lattices in which the distortion would be local. A larger number of solute atoms would be required to produce the limiting degree of distortion in the "hard" lattice, and that explained the fact, not fully recognised until these ideas were put forward, that it is the hard metals of high melting point which form long series of solid solutions, while soft metals of low melting point generally form eutectiferous alloy systems showing only low solid solubilities.

The lecturer then explained a series of inferences from his theoretical ideas, relating to the behaviour of alloys on melting and freezing, the relationship of the hardening effect of an added metal to its solubility, and other physical properties. In all cases the inferences from the theory could be qualitatively verified, and in some cases predictions had been successfully made, notably of the fact that where the addition of another metal raises the melting point of a solid solution a diminution of the lattice spacing results, as verified in silver-palladium, copper-nickel and other series. Some reference was also made to the mechanism of plastic deformation of metals by slip, and the effect of lattice disturbance occurring on slip surfaces. The lecturer made use of an unpublished idea derived from some recent work of Gough and Hanson, suggesting that the hardening of cold-worked metals may be due to a "rumpling" of the crystal lattices. The persistence of such rumpling, however, could only be explained by the presence of layers on which the lattice structure had been seriously disarranged. Layers of the lattice adjoining such disorganised regions would be distorted, since some of the atoms could no longer be in equilibrium in their normal geometrical positions. The hardening caused by cold work might be due to this "rumpling" of adjacent lattice layers rather than to the physical properties of thin amorphous layers on the slip surfaces.

In the third lecture the theory of lattice distortion was applied first to the question of electric conduction in metals, then to magnetic phenomena, and finally to the question of the colours of alloys. The electron mechanism of electric conduction in metals was discussed, the difficulties of the various theories being pointed out, but the fact that electrons must pass through or between the atoms of a metal had to be accepted, and the lecturer pointed out, mentioning that it had been suggested by Lindemann some years before, that the passage of electrons would be easier if the lattice were perfectly straight and regular than it would be in a lattice slightly distorted either by the presence of stranger atoms in a solid solution or by thermal oscillation of the atoms. The straightening out of the lattice of a pure metal, as absolute zero is approached and thermal oscillations die down, helps to explain the phenomena of "super-conductivity" discovered by Kammerlingh Onnes, but the lecturer pointed out that if lattice irregularity were the only cause of resistances, all pure metals should become super-conducting at temperatures near the absolute zero. Actually, the phenomena are only observed in a group of metals occupying a particular region of the periodic table, so that there must be a certain part of the resistance of other metals due in some way to the inter-atomic linkage as well as to lattice distortion. The behaviour of alloys as regards electrical conductivity, and particularly their occasional very low temperature coefficient of resistance, however, follow readily from the lattice distortion theory.

The next step in the lecturer's argument was that when a lattice is distorted by the presence of stranger atoms, the atoms situated on that lattice, being no longer held together by perfectly symmetrical forces, must also be to some slight degree "distorted." By the distortion of an atom he would understand some displacement or constraint upon some of the electron orbits, perhaps mainly on those of the outer shells. Even that, however, would affect the behaviour of the atom, particularly in regard to magnetism and its response to radiation. Recent theories of magnetism suggested that magnetic properties were due to some slight dissymmetry of the atoms, and any slight distortion due to external forces might very largely affect such a small dissymmetry and therefore largely affect magnetic behaviour. The properties of silicon and aluminium steels and of "Permalloy" were considered from this point of view, and the suggestion made that the remarkable magnetic properties of the latter alloy, containing approximately 79 per cent. of nickel and 21 per cent. of iron, might be due to some special symmetrical arrangement of the iron atoms on the nickel lattice resulting in a degree of atomic distortion peculiarly favourable to the magnetic properties of both. Slight plastic deformation, by causing slip, would destroy such an arrangement and produce—as it actually does—an entirely disproportionate diminution of magnetic quality.

The general question of "symmetrical" solid solutions was then discussed, on the basis that if in a solid solution the stranger atoms were enabled to take up a symmetrical arrangement, there would no longer be any lattice distortion, and the resulting material would behave like a pure substance rather than a solution, but this behaviour would be upset by plastic deformation. The fact that the "solidus" curve of the copper-nickel system on closer examination appears to curve somewhat towards the liquidus was taken as evidence that there is a real tendency towards the formation of symmetrical solid solutions in those alloys.

Dr. Rosenhain then discussed the problem presented by the colours of alloys, particularly those of the deeply coloured metals like gold and copper. The colour is due to selective absorption of light of certain wave-lengths, but if the atoms are distorted by the formation of a solid solution, this distortion must affect the electron orbits and therefore their selective light absorption. A progressive change of colour with increasing concentration of the solution was, therefore, to be expected. In some alloy systems, however, a limit of solid solubility was reached, and then a new phase was formed. Such a phase was formed simply because it was an arrangement of the two kinds of atom in which the energy content—*i.e.*, lattice distortion—was less than it would be in the original solution if carried to higher concentration. It followed that the distortion of the atoms should be less in the new phase than in the saturated original solution, and—if these ideas were true—a recrudescence of colour might be anticipated. The lecturer showed that in the copper-zinc alloys this occurs, the beta phase being very decidedly more red than the saturated alpha phase. On the other hand, the powerful effect of nickel in discharging the colour of copper was ascribed to the greater atomic distortions resulting when a lattice is compressed than when it is expanded.

The lecturer finally dealt with inter-metallic compounds and symmetrical solid solutions, pointing out that X-ray analysis had shown that in certain well-defined compounds the inter-atomic distances were altered far beyond anything met with in solid solutions. This could only be explained by supposing that in such a case as the compound $CuAl_2$ the copper atom had taken from each of two aluminium atoms something—presumably one or more electrons—which allowed the two aluminium atoms to come very much closer together than they could otherwise do. In such a combination, however, it would obviously be impossible to replace an atom of either kind by an atom of the other, so that compounds would not be expected to be capable of holding in solid solution either of their constituent metals, although they might take up a third metal. On the other hand, the inter-metallic compound itself would constitute an aggregate too large to serve as a substitute on the lattice of a pure metal, so that, as a rule, we must regard such compounds as passing into solid solution as individual atoms, *i.e.*, as being entirely dissociated. In rare cases it might happen that the "unit lattice cell" of a compound could be built into the lattice of another metal without being broken up, but the occurrence of such cases had not yet been proved.

In conclusion, the lecturer drew attention to the far-reaching importance of the conceptions he had discussed, pointing out that once it became possible to determine the "limiting lattice parameters" of metals and alloys for the different kinds of atoms, it would be possible to predict quantitatively the behaviour of the metals when alloyed, not only for simple binary or ternary alloys, but for the more complex mixtures which had frequently to be used.

THE remarkable progress made by Italy during the past twenty years in industrial chemistry will be illustrated this spring at the National Exhibition of Chemistry to be held in Turin. Special features will be made of electro-metallurgy in its various phases, illustrated by practical demonstrations. The production of atmospheric nitrogen by the Italian Fausser and Casale patents will demonstrate progress in a field of prime importance to Italian agriculture, as well as to national security. There will be a section devoted to chemistry in its relation to munitions of war. A model plant will show the processes in the manufacture of artificial silk and in paper making, both outstanding instances of the application of chemistry to manufactures. The purpose of the organisers is to make this exhibition as attractive to the ordinary visitor as it will be instructive to the technician. It will also lead to a scientific result of permanent value, as the Radium Pavilion will, at the close of the Exhibition, be transformed to the National Radium Institute for the study of all radio-active substances and their scientific, therapeutic and industrial uses. This Institute will be organised on a scale which will make it one of the most important in the world.

Institute of Metals.

The annual general meeting opened in the Hall of the Institution of Mechanical Engineers, under the presidency of Professor Thomas Turner, on March 11th.

The President, in bringing up the report of the Council, stated that the industries with which the activities of the Institute was concerned had not suffered so severely from the trade depression as the crude metal trades. This fact was confirmed by the increase in membership during the past two years and the increasing support generally from makers, users, and workers in the non-ferrous metals industries. The interest aroused by the contributions to the "Transactions" of the Institute had been shown by the fact that papers read before its meetings had been under discussion recently at a meeting in Berlin.

The report stated that the Council had received during the past year a donation of £1000 from Mr. L. Sumner, past-president. This sum was placed at its disposal without any reservation, beyond a suggestion that it should be used for the permanent benefit of the Institute. It had been invested—in 4 per cent. Funding Loan—and the Council proposed to regard the investment and the interest accruing thereupon as the nucleus of a House Fund. For some years past it had been realised that the Institute needed more house room. A Committee had been appointed to consider the question of securing additional office accommodation, but lack of funds prevented any change being made at present. It was hoped that other members would follow the past-president's example and make donations to the House Fund, so that ere long it might be possible for the Institute to be suitably housed.

The work of the Corrosion Research Committee had been reorganised during the year. Experience had shown that it was desirable to separate the theoretical and technical branches of the work, and as a result of communications which passed between the Department of Scientific and Industrial Research and the Committee it was agreed the former should make itself responsible for the purely scientific investigation of corrosion phenomena, while the latter undertook to continue the technical work in connection with condenser tube corrosion. This arrangement was confirmed by the Committee of the Privy Council and the Council of the Institute.

The work of the Aluminium Corrosion Sub-Committee had been wound up, and a final report had been presented to the Department of Scientific and Industrial Research, but pending the clearing up of the position as regards patents no publication of results had been permitted.

The report of the Honorary Treasurer indicated that the period of deficits in the accounts of the Institute is coming to an end, and the hope was expressed that the current financial year, 1924–25, will show a small balance on the right side.

The ballot for officers for the year 1925 resulted as follows:—President, Professor Turner; vice-presidents, Sir John Dewrance and Sir William Smith; members of Council, Mr. W. R. Barclay, Dr. D. Hanson, Dr. R. S. Hutton, Sir Charles Parsons, and Mr. F. Tomlinson.

The first paper taken was that by Mr. H. T. Angus and Mr. P. F. Summers, "The Effect of Grain Size upon Hardness and Annealing Temperature."

THE EFFECT OF GRAIN-SIZE UPON HARDNESS AND ANNEALING TEMPERATURE.

It is shown that the grain-size of a metal just before rolling considerably affects the hardness of the metal when annealed, after rolling at temperatures up to the recrystallisation temperature. It is well known that many heavily worked metals increase in hardness on annealing for a short time at relatively low temperatures, and this property is shown to depend, among other things, upon the grain-size that existed at the time of rolling. A coarse grain-size increases this rise in hardness and the range of temperature over which it extends, whereas with a fine grain-size softening may commence at much lower temperatures. This effect was noted in both pure copper and bronze containing 4.5 per cent. of tin. It was also observed that the recrystallisation temperature of copper is higher in the coarse-grained metal than in the fine-grained, in which almost complete softening occurs before signs of recrystallisation appears; while in the coarse-grained copper the same degree of softening is only reached when complete recrystallisation occurs. The relation between grain-size and hardness for copper and bronze shows that as the grain-size increases after recrystallisation, the hardness decreases correspondingly. It was found by calculating the area of grain boundary per cubic millimetre of metal from the grain-size, and plotting against hardness, that a straight line was obtained, indicating that the hardness varies directly with the area of grain boundary per unit volume of metal.

Professor F. C. Thompson referred to two conclusions outlined in the paper. The first was that the hardness effect before recrystallisation was not common to the metal as a whole, but was fundamentally connected with the grain size. The second was the claim of the authors that it was possible to obtain complete softening on annealing before recrystallisation took place. It was a remarkable fact that after complete softening a hardening effect should be obtained, but proof of its existence had been given by the behaviour of nickel, silver, and other metals.

Dr. W. Rosenhain also commented on the phenomenon of complete softening of the metal after recrystallisation, which, he pointed out, was contrary to generally accepted ideas and required more evidence. It was not always easy to be certain when recrystallisation had occurred, and on that point he would give a word of warning. One interesting fact which emerged from the paper was that the past history of a metal had a great effect upon its properties until it had been recrystallised at a very high temperature.

Dr. H. W. Brownsdon referred to the low hardness figure which had been obtained, and thought that on that point the authors had drawn conclusions on insufficient evidence.

Miss Elam, drawing on evidence derived from work on aluminium, questioned whether the removal of hardness was complete before recrystallisation.

Colonel Belaiew referred to the influence of grain size on hardness. He had found, in some experiments on steel, that it might cause a fall in the hardness value from 197 to 156. It was possible for variable figures to be obtained when using small balls to determine the hardness figure.

Dr. W. H. Hatfield, as the result of work on certain commercial metals, was inclined to support the contention of Miss Elam that it was not possible to obtain complete softening until recrystallisation took place. The whole subject was one of great importance.

Mr. Angus, in reply, said it was interesting to know that increase of hardness after softening took place in other alloys. Perhaps a finer grain size was associated with the rise in hardness. It was not easy in a complex metal to establish the relation between grain size and hardness. It was shown, however, in homogeneous alloys in which no component was harder than another.

Mr. S. L. Archbutt presented a paper describing "A Method of Improving the Properties of Aluminium Alloy Castings."

ALUMINIUM ALLOY CASTINGS.

The experiments described in this paper and the results obtained from them are to be regarded as indicating the possibilities of a method of treating aluminium and certain of its alloys, which serves to eliminate at all events a considerable proportion of dissolved gas, and thus reduces unsoundness, and to a considerable extent removes pin-holing. The process suggested consists in allowing the molten alloy or metal to cool slowly in the crucible in the furnace until it has just completely solidified; it is then remelted, and may be carefully stirred, raised to the pouring temperature, and cast. Ingotting the metal is not satisfactory, as the ingots cool too quickly, and during remelting are too much exposed to the furnace gases. In a later experiment described, passage of an inert gas through the melt during slow cooling and solidification has been found to improve still further the soundness of resulting sand cast bars. Slightly anomalous results have been obtained in some cases; and it is not yet clear how far the method is of value in other alloys, whether consisting mainly of aluminium or of other metals. It is evident that much further investigation is required. Meanwhile, the author has learnt that simultaneously and independently, Professor C. A. Edwards and Mr. W. E. Prytherch, of Swansea, working on the effect of gases in copper, for the British Non-ferrous Metals Research Association, have discovered a similar effect obtained by solidification in the crucible in the case of pure copper.

Dr. R. Seligman said that the paper was of outstanding interest to the aluminium industry. The phenomena to which attention was directed was not uncommon, and the effects were more widespread than was generally believed. Metal in the sheet form might be of high quality, and yet prove very difficult to weld, and he had no doubt that the true explanation was that given by Mr. Archbutt in the case of castings. His investigation of the effects of occluded gases explained many things which had been rather baffling, and the great merit of his work was that he indicated means of overcoming these difficulties. It might be said that the practical foundryman would not altogether approve of the method suggested by Mr. Archbutt, but his opinion was that it was the business of those engaged in industry to discover a workshop method of using the remedy proposed by the author, and not to blame the scientific man. He noted the suggestion that the gas was liberated during solidification, but it was necessary to know the nature of the gas, and whether it was the result of original sin or was due to methods of remelting. It was natural that those engaged in industry should suspect the manufacturers, and if treatment of the kind suggested in the paper was essential, the makers of the metal should be charged with that duty.

Colonel Belaiew raised the problem of the small factory in which there would be obvious difficulties in applying the process described in the paper.

Dr. A. G. C. Gwyer said that his knowledge of the subject suggested that the gas in aluminium was hydrogen. With regard to the question of where the process should be carried out, if it were done by the producers of the metal it was necessary to consider whether after the remedy had been applied the metal could be made bad again.

Dr. W. Rosenhain challenged the suggestion that the method described in the paper was not one which could be applied in practice. It was simple, easily carried out, and the cost was small. The question had been asked if the metal could be made bad again. The material could be spoiled by remelting, if it were exposed to an undue extent to furnace gases, but it was possible to adopt a method by which the remelting would do very little harm. It was a common criticism that methods adopted at the National Physical Laboratory could not be used in industrial establishments, but the laws of nature applied in both cases, and the laws of intelligence should be the same. Reference had been made to the question of melting under reduced pressure, but some recent experimental work had shown that melting in vacuo failed to give the desired result. The process dealt with in the paper was possible of application to many other metals and alloys, and would throw light on rates of solidification, solubility of gases and other points.

Mr. Archbutt, in reply to the discussion, said that some of the points raised had been dealt with by Dr. Rosenhain. A question had been asked as to the nature of the gases given off. They were mainly hydrogen, but a small quantity of nitrogen was also present. A great deal of work on the subject discussed in the paper still remained to be done, but he hoped that it would be agreed that enough had been already achieved to justify the publication of results. The work was being continued.

Mr. Ulick R. Evans gave a brief abstract of his contribution, "Surface Abrasion as a Potential Cause of Localised Corrosion."

SURFACE ABRASION AND CORROSION.

Previous work has indicated that most cases of serious corrosion are of an electro-chemical character; for electro-chemical action usually gives rise to soluble primary corrosion products, whilst direct chemical oxidation would generally produce an insoluble body *in situ* on the metallic surface, which would tend to obstruct further attack. Bengough has indicated that local abrasion—by causing removal of the obstructive film—may allow local attack, whilst von Wurstemberger has suggested that very severe corrosion may be occasioned by electric currents flowing between the bare abraded portion and the still encrusted area. An experimental investigation has been made regarding the existence of these currents. Sometimes they flow in such a direction as to localise corrosion on the small abraded portion, sometimes in the contrary direction. But they are generally transitors, dying away soon after abrasion ceases. Moreover, the abrasion required to produce these currents must, in most cases, be sufficient to damage the metal by mechanical erosion also. In the case of the corrosion of zinc by hydro-chloric acid, the wiping away of the black scum of residual impurities—lead, &c.—actually diminishes the rate of attack; the impurities, if allowed to accumulate, act as the cathodic members of the corrosion-couples and facilitate the liberation of hydrogen. Vernon's statement that commercial (impure) zinc is attacked more slowly than some grades of much purer zinc, is, however, confirmed; probably "homophase" impurities (in solid solution) behave in the opposite mode to "heterophase" impurities (present as a separate phase).

Dr. Guy Bengough said that any paper dealing with the effects of abrasion was important from the practical standpoint. With most of the subject matter of Mr. Evans's contribution he was in agreement. There were, however, one or two points to which he took exception. It was necessary to distinguish between true erosion of the metal and erosion of the scale and chemical attack. Mr. Evans' experiments must be considered with these differences in mind.

Dr. W. H. Vernon welcomed the paper for the reason that it dealt with a branch of the corrosion problem which had not hitherto been made a subject of intensive study, but which must receive more attention if the corrosion problem were to be solved. It was clear that the influence of the corrosion product was an important factor, as in actual practice a greater effect was associated with the product than with the initial process of corrosion. A considerable measure of agreement between rival schools of thought had now been reached on the initial mechanism of corrosion, and there was evidence of this fact in the second part of the paper now presented by Mr. Evans. It was not now disputed that extreme purity of material was unnecessary to secure freedom from the attack of the agencies which produced corrosion, and the separation of the metal into anodic and cathodic areas as a condition of electrolytic corrosion was now viewed as a question rather of convenience than anything else. A point of much interest brought out in the paper was the higher degree of immunity from attack of commercial zinc, containing a small percentage of impurities than the pure metal, and the explanation given by Mr. Evans appeared to meet the case fairly well.

Mr. Evans, in closing the discussion, to which the President intimated that contributions would be made by correspondence, said that he had safeguarded himself on the points raised by Dr. Bengough. Reference had been made to the effect of a plain sea water jet and one containing sand. In the case of a water jet that would include air bubbles and would set up capillary forces powerful enough to peel away the scale from the metal. Abrasion by sand was capable of causing chemical erosion as well as corrosion. If he could so express his views, he would say that he was more in agreement with Dr. Bengough than Dr. Bengough was with him.

This concluded the morning session.

Annual Dinner.

On Wednesday evening the annual dinner of the Institute was held at the Trocadero Restaurant, London, under the chairmanship of the President, Professor T. Turner. About 180 ladies and gentlemen were present. Submitting the toast of "The Institute of Metals," the Right Hon. Neville Chamberlain, Minister of Health, recalled the time when he studied metallurgy under Professor Turner in the days before Birmingham University was established. Another of Professor Turner's pupils, he said, was the present Premier, Mr. Baldwin. Speaking of the prevailing depressed state of industry, he remarked that he and many others were coming to the conclusion that salvation could not be expected to come from any Government, however constituted, but that it must come from industry itself. Professor Turner responded to the toast. The toast of "Kindred Societies," proposed by Dr. Walter Rosenhain, was acknowledged by Mr. W. H. Patchell, and "The

Guests," submitted by Sir Thomas Kirke Rose, was responded to by Lord Morris, Vice-chairman of the Imperial Mineral Resources Bureau.

SIXTY YEARS AGO.

IN the course of a letter to the Editor extending to the unusual length of four columns, Mr. James Field-Meagher, in our issue of March 10th, 1865, covered much ground and a variety of subjects concerning the universe, its extent and nature and the foundation of the so-called "laws" which man had evolved in his efforts to interpret natural phenomena. The letter was a curious one. We read it to-day with a somewhat fuller knowledge of the universe than was possessed by the writer and his contemporaries, but we must bow to him even now for the depth and sincerity of his speculations. In many places he passed from the physical to the moral standpoint, from the contemplation of nature to the study of thought and mind, and in it all we see a very striking anticipation of ultra-modern tendencies in science and psychology. It cannot be an exaggeration to say that Mr. Meagher definitely anticipated Einstein. Time, he held, was only an imaginary interval supposed to elapse between the movements of a body from one situation to another. How, he asked, could that which was defined as illimitable be divided into parts, how could something supposed to be without beginning or without end be imagined as divisible? Time intervals, say the modern relativists, are not real things belonging to the event observed, but are quantities imputed to the event by the observer. Again, we find Mr. Meagher anticipating Einstein in his conception of what we call light. "Already," he wrote, "there would appear to be one glorious and immortal thing occupying its situation in the universe—Light." According to the relativists the possibilities of nature are limited by the velocity of light; there can be no relative velocities greater than 186,000 miles a second. As for absolute motion Mr. Meagher argued that it did not exist, on the simple ground that it was as impossible to conceive of a body without dimensions being capable of absolute movement as it was to imagine one without extremities as being capable of division into parts. To the modern relativist motion in absolute space is meaningless. In another passage Mr. Meagher spoke of recalling the ages of the world and re-peopling space itself with spheres that may have long since ceased to wander through it. The 4-dimensional world of the relativist is a static world with, to quote the words of a recent writer, "the events of the past, the present and the future all definitely located in it." Finally, speaking of the so-called laws of nature Mr. Meagher wrote:—"That order and regularity, to which science so much pretends, is only one of the resources to which human nature has recourse to seek to allay its fears, and it may yet be discovered that the harmony accorded by the living to the material world may have been the most curious of all the delusions it succeeded in imposing on itself." The theory of relativity attacks the Newtonian harmony as a delusion, and characterises it not only as curious but as absurd.

INSTITUTION OF MECHANICAL ENGINEERS.

IN view of the centenary of the opening of the Stockton and Darlington Railway in 1825, and the connection of the President, Sir Vincent L. Raven, K.B.E., with the North-East Coast, the Council has decided, as already announced, that the summer meeting of the Institution shall be held in Newcastle-upon-Tyne, beginning on Monday, July 6th. The business meetings will be held at Armstrong College, by kind permission of the University of Durham, which is also providing facilities for the secretarial office, writing rooms, &c. The North-East Coast Institution of Engineers and Shipbuilders is kindly placing its library and reading room at the disposal of the members during the meeting. Professor C. J. Hawkes, M.Sc., is acting as the honorary local secretary.

PROVISIONAL OUTLINE PROGRAMME (*subject to revision*).

Monday, July 6th.—Arrival in Newcastle.

Tuesday, July 7th.—Morning: The Right Hon. the Lord Mayor of Newcastle-upon-Tyne and members of the local reception committee will receive and welcome the President, Sir Vincent L. Raven, K.B.E., the Council and members of the Institution with their ladies in the King's Hall, Armstrong College. Reading and discussion of paper on "Three-cylinder Simple Locomotives," by Mr. H. N. Gresley, C.B.E., member of Council. Afternoon: Either visits to works in Newcastle and district or visit to Durham (ladies included). Evening: Reception and dance in the Grand Assembly Rooms, by invitation of the Right Hon. the Lord Mayor and the Lady Mayoress, on behalf of the City Council of Newcastle-upon-Tyne.

Wednesday, July 8th.—Either whole-day visit to Darlington, to commemorate the centenary of the opening of the Stockton and Darlington Railway, by invitation of the London and North-Eastern Railway Company, which is arranging an exhibition of rolling stock, showing the progress from 1825; or visit to works. Afternoon: Garden party for the ladies at Jesmond Dene, by invitation of the Lady Mayoress (Mrs. Walter Lee). Evening: Institution dinner.

Thursday, July 9th.—Alternative visits to works. Whole-day excursion to Alnwick or Holy Island (ladies included). Evening: Reception and dance at Armstrong College.

Friday, July 10th.—Morning trip on the Tyne, by invitation of the Tyne Improvement Commissioners. Whole-day excursion to visit the Roman Wall (ladies included).

THE TAFJORD POWER DEVELOPMENT.

A DESCRIPTION of the Tafjord power development, the first 100,000-volt installation in Norway, appears in the form of a *Bulletin Oerlikon*, No. 42. The power station described is at the head of the Norddals Fjord, 75 miles from Aalesund. The catchment, 114 square miles in area, is among the mountains, which include peaks up to 6500ft. altitude, but no glaciers of importance. Direct measurements which have been taken since 1919 show a run-off of 514 cusecs, corresponding, it is stated, to a rainfall of 63in., actually to a run-off of 97 per cent. of 63in. The total head available is being utilised in steps; there will be two power stations in the Tafjord area below Onilsa Lake, which acts as a reservoir, and a third station near Kaldhusdalen. Assuming that the load factor will amount to 0.7 and that the last-named station will operate for seven months in the year, it will be possible to develop 100,000 horse-power in all, the water being stored during the other three months. The upper, middle, and lower stations will have plant capable of developing, respectively, 25,000, 45,000, and 90,000 horse-power. The power is transmitted at 100,000 volts and distributed at 20,000 volts.

The Tafjord power station, which was put into operation towards the end of last year, is provided with turbines of the Francis type, 500 revolutions per minute, 84 per cent. guaranteed efficiency, and a normal rating of 8000 horse-power each. Two units are now working. The full head is 490ft., the water being conveyed from the base of the lake through the mountain by a tunnel 2600ft. long, to the head of the pressure pipe. The turbines are direct coupled to three-phase Oerlikon generators, designed for a normal continuous rating of 7500 kilovolt-ampères at 7000 volts, frequency 50 cycles, power factor 0.6. Each generator works in conjunction with an Oerlikon transformer having a ratio 7000 to 113,500 volts at light load. The transformers are of the core type, and immersed in oil. The oil is cooled in a separate cooler, in which the water is always at a pressure lower than that of the oil. Normally each generator with its transformer is a separate unit, but auxiliary bus-bars on the 7000-volt side allow of the connecting of a generator to a transformer other than its own. For the supply of the neighbouring district three smaller transformers, 7000 to 20,000 volts, have been provided.

The storage capacity at Onilsa Lake is 282 million cubic feet, calculated above the entrance of the tunnel, which is 59ft. below the top water level of the lake. More water could be stored by building a dam, probably 300ft. high, at the Zacharias Lake.

For the transmission line of some 50 miles long spans have been adopted. Where the line runs along the faces of steep cliffs the spans are from 2500ft. to 3000ft., the masts being of special design and the conductors of bronze with a section of 0.232 square inch. On other parts of the line the conductors are of copper and 0.077 square inch in section. A mountain pass 3800ft. in altitude is traversed by the line. A sub-station at the end of this land line is situated on the coast, and from here high-tension cables have been laid to islands lying off Aalesund. Some 17 miles of this cable have been laid at depths ranging from 65ft. to 195ft.

THE WIRELESS SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

IN a paper read before the Wireless Section of the Institution of Electrical Engineers on Wednesday, March 4th, Mr. D. W. Dye, of the National Physical Laboratory, read a paper on "Current Transformer Methods of Producing Small Known Voltages and Currents at Radio Frequencies for Calibrating Purposes." The method described by the author involves the use of a current transformer, across the secondary of which a resistance of known value is connected. A thermo junction or other device serves to measure or to set the primary current. Voltages ranging from a few microvolts up to a few tenths of a volt may be produced. The paper deals with the nature and extent of the errors and the precautions that are necessary to reduce them to a negligible amount. Various uses of the method are touched upon, and the limitations of the method are given. The method of applying the voltage to other apparatus naturally varies considerably, according to the conditions which must be maintained in the apparatus and in accordance with its impedance. The conditions to be considered are the effect on the applied voltage of the circuit to which it is applied and the effect on the circuit of the application to it of the resistance across which the applied voltage is produced.

Another paper was read at the same meeting by Lieut.-Colonel K. E. Edgeworth and Mr. G. W. N. Cobbold on "The Measurement of Frequency and Allied Quantities in Wireless Telegraphy." It has been customary, the authors state, to define the oscillation frequencies of wireless in terms of the lengths in metres and kilometres of the corresponding ether waves. During the last few years, however, there has been a tendency to abandon this indirect definition, and to state the frequencies themselves in cycles per second or kilocycles per second. The paper suggests another alternative, namely, to describe the frequencies in terms of pitch, a term which is defined as a relationship of the particular frequency to some standard frequency. The proposed standard is a frequency of 1 cycle per second and the relationship suggested is such that the pitch is a logarithm of the ratio between these frequencies. Some of the advantages of the use of "pitch" are described, and particular emphasis is laid on the advisability of employing it in the case of very short waves.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ROLLER BEARINGS FOR HEAVY LOADS.

SIR,—I have read with considerable interest the leading article published in THE ENGINEER of February 27th.

The conclusions drawn from the paper by Mr. Dahlerus and from the subsequent discussion, that, compared with a well-designed and well-lubricated plain bearing, the roller bearing can offer little advantage, would appear to be justified by the results obtained from trials on the Midland Railway, but I do not think that this argument can be applied to the case of the rolling mill.

Certainly the average roll bearing is a fairly crude affair and is entirely lacking in proper lubrication; but even when compared with the best type of roll bearing available at the present time, having an ample supply of lubricant, the roller bearing has proved its superiority not only by eliminating hot bearings, but in the primary function of reducing very considerably the power absorbed by the mill.

It is not so much that the plain roll bearings is badly designed, as that average loading and working conditions are almost impossibly severe. The diameter of the journal or neck must from considerations of strength be large in proportion to the diameter of the roll barrel; the intensity of pressure on the bearing may be anything from 1000 lb. to 3000 lb. per square inch, and even with cold rolling sufficient heat is generated by the metal passing through the rolls to increase progressively the temperature of the whole body of the roll, quite apart from any heating from journal friction.

I think it will be generally agreed that to design a plain bearing which will stand up to these conditions without excessive heating and considerable loss of power in friction is a difficult problem. The best type of modern cold rolling mill is fitted with plain bearings, lined with anti-friction metal, with internal water cooling of both bearings and rolls and have a thoroughly efficient system of lubrication. With proper attention they can be relied upon to work continuously under the usual load conditions without excessive heating or serious loss of power; but even then the power absorbed in roll bearing friction is much greater than in the case of a mill with roller bearings.

With regard to durability, it is fully realised that roller bearings would require replacement in time, but so also do plain bearings, the life of which may be long or short, depending on the attention given to maintain them in good condition, and the expenditure in lubrication, whereas the roller bearing will continue to operate satisfactorily with little or no attention beyond the very occasional supply of lubricant.

It would appear, therefore, that the roller bearing is eminently suitable for heavy loads and comparatively slow speeds, whereas probably the best type of plain bearing is working under favourable conditions with medium and light loads and high speeds.

Apart from the above it is a little surprising that in the discussion of the paper no reference was made to the universal use of ball bearings in automobile construction, without which I believe the modern motor car would scarcely be a practical proposition, and again in the humble bicycle, where the durability and friction-reducing properties of the ball bearing under the most severe conditions have been proved beyond doubt.

Bedford, March 5th. C. E. DAVIES.

MAIN LINE RAILWAY ELECTRIFICATION.

SIR,—The question of telephone interference, to which Mr. J. Sayers refers in your issue of February 27th, has been fairly well investigated from its technical aspects, and M. Bachellery's own words, "the whole line between Perpignan and Villefranche, 30 miles long, only fed at one end, is actually worked with single-phase current without any trouble on the telegraphs and telephones," show that interference difficulties have been successfully overcome.

I think that engineers at the moment are rather inclined to regard the question as an economic one. I am not able to go into the matter further at the moment, owing to the fact that I am just engaged in the preparation of a report on this subject for the British Electrical and Allied Industries Research Association, and this places restrictions on my publications for the time being. However, as Mr. Sayers is also a member of the Committee under whose instructions I am working, this will only be a temporary drawback, as he will soon have the available evidence at his disposal. G. PARKER SMITH.

Glasgow, March 3rd.

SUBMARINE RAILWAY TUBES.

SIR,—I, for one, was greatly interested in your recent quotation from *Le Génie Civil*, descriptive of Commandant J. Veyrier's proposed submarine railway tube—see page 245 of your issue for February 27th—as some years ago I amused myself with a somewhat similar proposal in connection with my "High-speed Land and Sea Vacuum Railways," which formed the subject of a paper to the Society of Engineers and is roughly described in that Society's *Journal* for 1917.

In both inventions it is proposed to construct the tubes in sections to be launched, towed out, ballasted down, and fitted together similarly, the work commencing in mid-channel and the tubes terminating in temporary wet docks on each shore. I proposed pendant holds for water and other ballast and for mooring, and removable turrets reaching to the surface during construction; also means for preventing or dealing with leakage. Both designs are for constructions of iron and concrete and show a somewhat similar method of joining the tube sections.

Here, however, their similarity seems to end. I only propose such tubes for crossing channels too deep and difficult to tunnel, and rely on buoyancy alone to support the tube and its cars, with a slight excess to keep taut strong cables by which it would be kept at the required depth and in the right position laterally. Even where the bottom admits the construction of piers I fail to see their necessity for tubes whose buoyancy can be made to give more than sufficient support. Rough heavy mooring blocks at regular intervals, but otherwise sunk anyhow along the route, would certainly be a far easier and cheaper method of construction than that proposed by Commandant Veyrie, whose tubes also appear to have the disadvantage of having nearly to follow the undulations of the sea bed instead of being kept at one level, as I propose. He, of course, designs for ordinary railway vehicles, hence his pair of larger tubes in place of the single and rather smaller one I propose for light cars running in vacuum at a sufficiently higher speed to carry the same passenger traffic through the much less costly structure I advocate.

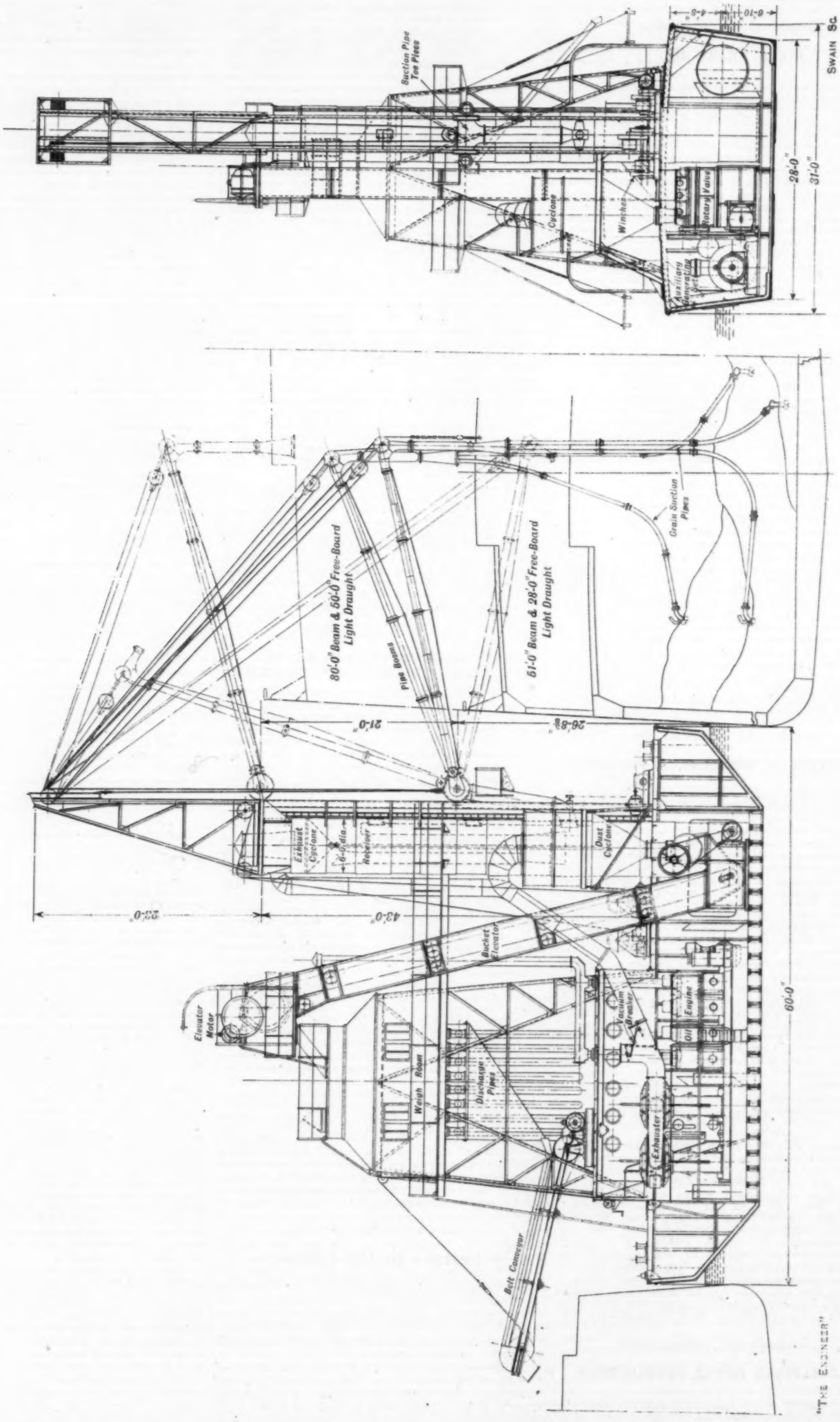
However, I only advise such tubes for channels such as those between Great Britain and Ireland, where tunnels are impracticable. But for the Straits of Dover a tunnel would be best, especially if in the form of a smaller high-speed "London and Continental Vacuum Tube." As I have written you on this subject before—see page 354 of your Vol. CXXXVII.—I will not again inflict on your readers particulars of that proposal, as most deem all such schemes impracticable. Perhaps they are so to the busy and elderly members of the profession, but the younger may employ their time to worse purpose than on an impartial study of such proposals as the future may demand of them, for be it not thought that air transport will ultimately outrival the ground, either in safety, speed, or cost, where or when the traffic is sufficient to justify the greater initial outlay on special high-speed lines. ARTHUR OATES.

Bradford, March 9th.

GRAIN ELEVATOR FOR THE PORT OF LONDON

EAST FERRY ROAD ENGINEERING WORKS COMPANY, LIMITED, MILLWALL, ENGINEERS

(For description see opposite page)



"THE ENGINEER"

Floating Pneumatic Grain Elevators for the Port of London.

IN this article a description is given of two new grain elevators of the floating pneumatic type, which have been built to the order of the Port of London Authority, by the East Ferry Road Engineering Works Company, Limited, of Millwall, London. The vessels are named the Legion and the Phalanx respectively, and are identical in design. They were placed in commission early last year, so that detailed particulars of their performance can definitely be given. We understand that the design of the machinery embodies several new features which mark a distinct departure from the firm's earlier practice. The grain to be discharged is sucked from the hold of the ship and is delivered by a bucket elevator to the weighing room, from which point it may be discharged aft by means of a belt conveyor or to port or starboard through adjustable chutes.

The drawings reproduced opposite show the arrangement of the machinery, while on page 309 photographs taken during the erection of the elevators are reproduced.

In the following table the leading dimensions of the pontoon and some particulars regarding the machinery and its output are given :—

Hull Dimensions.

Length between perpendiculars	60ft.
Breadth moulded	31ft.
Breadth at bottom of pontoon	28ft.
Depth moulded	11ft. 6in.
Draught	6ft. 10in.

Machinery Particulars.

Type of exhauster	Two-cylinder, double-acting, oil engine-driven
Cylinder bore	40½in.
Stroke of piston	15in.
Normal speed	188 revs. per min.
Type of oil engine	Four-cylinder, two stroke, Beardmore-Speedwell.
Cylinder bore	15½in.
Stroke of piston	19in.
Normal speed	188 revs. per min.

Auxiliary Electric Generating Set.

Type	40 K.W. Beardmore Laurence-Scott
Normal speed	300 revs. per min.
Circuit voltage	220 volts
Designed average output of grain elevator	110 tons per hour

The pontoon was built by Edwards and Co., Limited, of Millwall, to designs which were prepared by the East Ferry Road Engineering Works, Limited. It is provided with a swim, both fore and aft, and the after swim is furnished with budget plates which facilitate the towage of the vessel. At each end of the machinery space water-tight bulkheads extend right across the pontoon, and are carried from the bottom right up to deck level. The hull is flush decked, and the deck fittings include the necessary bollards and fairleads for both towing and mooring the plant. For manœuvring the elevator a nine brake horse-power electrically-driven capstan is fitted on the forward deck. It will be seen that the machinery space is covered by a deck house, facilities being provided for lifting the cylinder covers of the engine and the exhauster, and withdrawing the pistons. Some eight tons of cast iron blocks are placed in the bilges on the port side of the hull to balance the weight of the machinery on the starboard side. It is interesting to note that when all the fuel tanks are filled and there is no grain in the elevator, the transverse metacentric height of the structure is 3.843ft., whilst a figure of 2.43ft. for the condition when the tanks are emptied and all parts of the elevator filled with grain, shows that the elevator has a large reserve of stability even under the most unfavourable conditions of loading.

THE GRAIN-HANDLING GEAR.

The Grain Suction Pipes.—The illustrations reproduced herewith indicate the special type of grain receiver and the suction pipe jibs which are employed. The design is new, and is the subject of patents by Mr. F. S. Tuckett, the managing director of the East Ferry Road Engineering Works. From the drawings opposite it will be seen that there are two main pipe booms, each of which is 35ft. long. The booms taper from 10in. diameter at the heel to 9in. diameter at the head. At this part of the boom a special bend formed of steel plates, so designed that the back may be renewed, is fitted. To each head there is attached a short length of "armadillo" flexible pipe, 9in. in diameter, which carries at the lower extremity a Y piece. From each of the Y pieces there depend two 6in. grain suction pipes which pass into the ship's holds. The pipes are of the rigid type with flexible joints and suction mouth pieces.

The effective length of the four grain pipes may be altered in any one of three ways; first, by luffing the main boom up and down; secondly, by adding extra 10ft. lengths of hold piping; and thirdly, by altering the position of the main pipe boom on the face of the receiver. Three different positions are provided for, which, without adding any extra suction pipes, gives a total range of 40ft. Referring to the views given on page 300, the construction of the main tee piece, or grain box, which carries the pivoted heels of the twin pipe booms may be noted. It is made of cast iron, and is suspended by wire ropes, which pass over sheaves at the top of the receiver and are attached to winches on the deck below. The tee piece is free to move up and down the receiver, and it travels on rollers which engage with runner bars built on to the receiver face. Beneath the tee piece there is a tubular extension piece terminating on a rectangular opening with a rubber jointed facing. Three corresponding openings are provided on the face of the receiver, to which the tee piece connection may be jointed. In the drawings on page 296 the pipe booms are shown attached to the first of these openings, which is about 9ft. 6in. above deck level. Ten feet higher is the second opening, shown in use in the illustrations reproduced on page 300, while 10ft. higher still is the top opening which is only employed in the top position of the boom, indicated by dot and dash lines on page 296. The joint between the tee piece extension and the receiver is made by means of a screw jack bar operated by a gypsy wheel and chain, which can be worked from the deck. Openings which are not required can also be closed with rubber-faced doors by toggle gear. The pipe heads are sustained in position by wire ropes passing over a sheave at the top of the receiver, and are attached to a winch on the deck. Provision is also made for an auxiliary lift of about half a-ton on each boom, which is made use of when extending or dismantling the suction pipes. The pipe handling and auxiliary lifts are controlled by motor-driven winches with tramway type controllers.

The Receiver and Dust Cyclones.—The grain receiver and the top exhaust cyclone, which latter feature forms part of Mr. Tuckett's patent, is a steel cylinder 6ft. in diameter standing 43ft. above deck level. It passes through the deck and is guided by an angle socket at that position. A few feet above deck level a sloping diaphragm is fitted inside the receiver, and communicates directly with the rotary valve or air lock by a rectangular duct through which the grain passes. On the top of the receiver is the superstructure for supporting the lifting and luffing gear sheaves. Inside the receiver there is a closed duct open at the bottom, which is joined to the three openings on the face of the receiver by cast iron connecting pieces. Air is drawn from near the top of the receiver by means of an outside pipe which passes down to the cyclone dust separator alongside the receiver. From the drawings on the opposite page it will be seen that this cyclone is of the usual type. It is 8ft. in diameter and 13ft. high and is supported on a high steel gantry. Inspection windows of glass are fitted at various levels. The cyclone discharges the dust through a rotary valve, this valve forming a third part of that used for discharging the grain. At this point reference may be made to the small exhaust cyclone at the top of the receiver. This cyclone is coupled to the discharge side of the exhausting pump, and its cone is connected by a pipe to the bottom of the main receiver through an adjustable valve, which is set so that the vacuum in the receiver causes any dust collected in the cone to be drawn down into the lower part of the receiver and mixed with the grain.

The advantage claimed for the arrangement of grain pipes and receiver which we have described is that, while the maximum required height of pipes —40ft.—is obtained, in the case of small cargo vessels the lowest position of the pipe boom can be selected at a height of only 26ft. 8in. above the water line. This position gives increased efficiency for the same vacuum and a smaller amount of broken grain. The difference in output, the makers inform us, is approximately 10 cwt. per hour for every foot of lift on the face of the receiver. Another point is the large cubic capacity of the receiver and the distance of over 25ft. between the point where the grain enters the receiver and the air suction connection. This distance gives less turbulence, and the tendency for grain dust to be caught up and entrained in the induction pipe is avoided. Glass windows are fitted at various points on the receiver to permit of interior inspection when the plant is working.

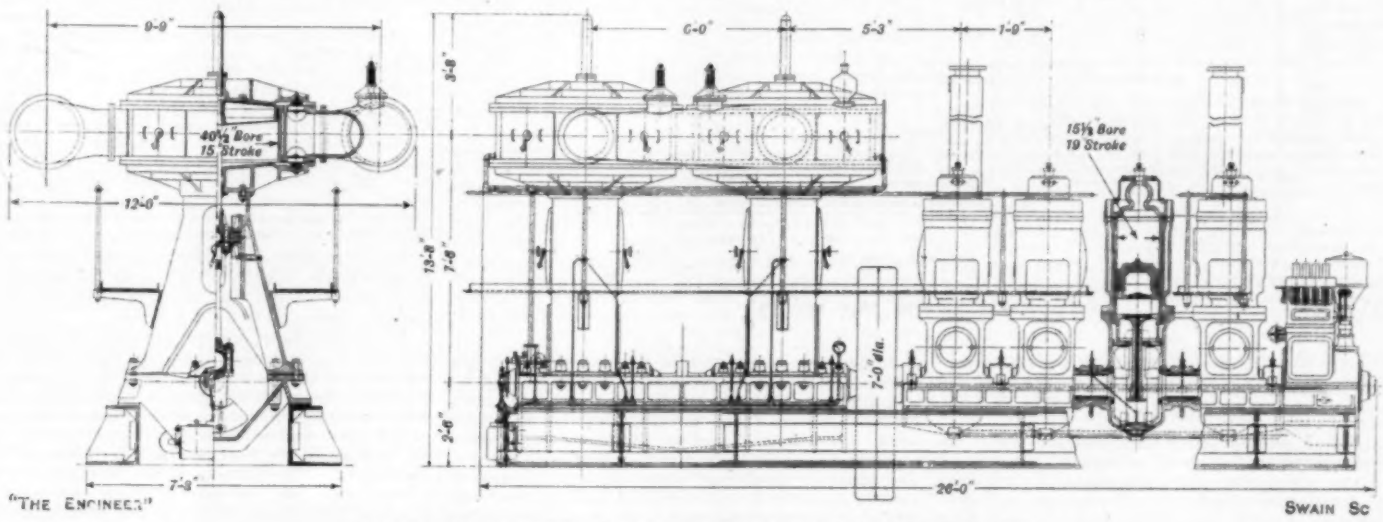


FIG. 1—GENERAL ARRANGEMENT OF THE OIL ENGINE DRIVEN EXHAUSTER UNIT

The Rotary Valve and Bucket Conveyor.—In the machinery room alongside the receiver and beneath the dust cyclone is the rotary valve or air lock. It is designed for a maximum output of 300 tons of grain per hour, the extra capacity allowing for gluts of grain or such obstacles as pieces of timber which may pass through the valve. In case of obstruction the valve is reversed electrically as soon as the motor driving it is overloaded. To avoid shock when reversing a raw hide belt drive is used from the 5 horse-power motor to the valve.

We learn that the valve has worked well, the average power taken on maximum load being 3.33 brake horse-power. The greatest power taken was a little over 4 horse-power, and the reversing gear has very rarely been used.

The air lock discharges the grain directly into the boot of a bucket elevator designed for a maximum capacity of 180 tons per hour. It is driven by a 15 brake horse-power motor mounted on the elevator hood, cast iron gearing enclosed in a steel casing being employed. The elevator is fitted with roller bearings and has two steel chains. Inspection doors are fitted, which give access to the working parts. A small davit is provided on the top of the elevator platform, which can be used to handle and lower any part of the machinery should occasion for its use arise.

The Weigh Room and Discharging Apparatus.—As shown in the illustrations which we reproduce on page 300, the weigh room is mounted on a latticed steel structure erected over the machinery space. In the centre of it there are eight Avery 250 lb. automatic dust-tight scales supported on steel bearers. Above the scales is the feeding hopper which forms part of the roof. It has a capacity of 6 tons and is connected to the scales by eight chutes, each fitted with a control sluice valve. The grain is fed into the hopper by the bucket elevator aforementioned, and is again discharged from the scales through eight three-way valves constructed of steel plate. The valves are operated from the deck, and by means of them the weighed grain may be discharged either to port or starboard on to a central hopper which feeds the belt conveyor arranged aft. It will be seen that the conveyor is pivoted and can be drawn up clear of all dock craft when it is not required. It is driven by a 5 horse-power motor through enclosed gearing. The conveyor has a designed output of

150 tons per hour and the belt itself is covered by a canvas hood to protect it from the weather. Extension chutes are provided for discharging the grain both to port and to starboard when filling lighters with bulk grain. When sacking the grain the work is carried out on timber platforms, elbows being fitted to the chutes so that the filling of the sacks takes place at a convenient height for handling. The discharging apparatus is so designed that the weighed grain can be discharged simultaneously in known quantities on both sides of the vessel and also aft. The ship is lighted throughout by electricity and large bunch lights are fixed to each pipe boom on the superstructure and also at each side of the weigh room.

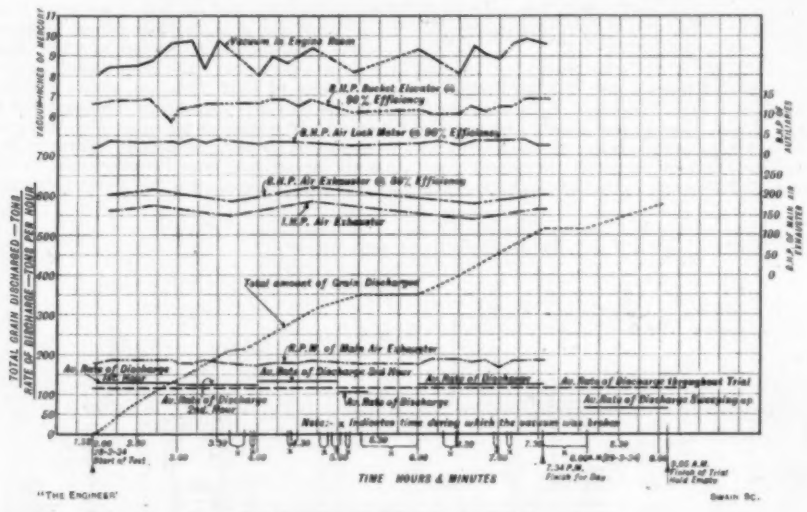

Vacuum in Engine Room
B.H.P. Bucket Elevator @ 90% Efficiency
B.H.P. Air Lock Motor @ 90% Efficiency
B.H.P. Air Exhauster @ 90% Efficiency
I.H.P. Air Exhauster
Total amount of Grain Discharged
R.P.M. of Main Air Exhauster
TIME HOURS & MINUTES

FIG. 2—CURVES SHOWING TEST RESULTS

THE MACHINERY EQUIPMENT.

In Fig. 1 we reproduce an elevation—partly in section—showing the main exhausting machinery, while two of the exhausters completed in the builder's shops are illustrated in Fig. 3. It comprises a double-acting two-cylinder exhauster, built by the East Ferry Road Engineering Works, Limited, which is driven direct from a four-cylinder Beardmore-Speedwell hot-bulb oil engine. These units are mounted on a common bed-plate fixed at the centre of the engine-room. The engine is rated for an output of 230 brake horse-power at a speed of 188 revolutions per minute, and its four cylinders are 15½in. in diameter and have a stroke of 19in. The fuel pumps and governor and control levers are placed at the end of the engine bed-plate, and the engine exhaust passes into a large silencer at the back of the engine and is discharged through water-cooled exhaust pipes to the main exhaust uptake. Between the engine and the exhauster a 7ft. fly-wheel is fitted. The exhauster is shown in detail in Fig. 1 and a general view is given in Fig. 3. The bed-plate columns and reciprocating parts are of robust design, and all bearings are provided with forced lubrication, which is supplied from an oil pump fixed at the end of the engine bed-plate. The reciprocating parts are enclosed by dust-proof covers, which are removable for purposes of inspection. The cylinders are water-cooled, and are each furnished with forty-eight spring-loaded disc valves of large diameter. The usual relief valves are fitted on the discharge branches of the exhauster. The pistons, it may be noted, are of a light box section, machined all over, and are fitted with two cast iron piston rings. A flake graphite lubricator is fixed on the induction pipe for the lubrication of the main cylinders of the exhauster. The exhausting unit is designed for an overload capacity of 275 brake horse-power, and a speed range of 20 per cent. above and 30 per cent. below normal speed, which enables the various qualities of grain and different discharge conditions to be dealt with. Provision is made for changing the speed of the engine while it is running, and at all times the speed is controlled from no load to full load by the governor. The plant is capable of maintaining a vacuum of 11in. of mercury if so desired, but under normal conditions of working only 8in. to 9in. vacuum is necessary. To facilitate easy starting, a vacuum breaker, consisting of two disc valves which can be controlled by a hand wheel from the engine platform, is provided. The necessary starting air bottles are fitted and the running equipment includes storage and ready-for-use fuel and lubricating oil tanks, vacuum gauges, tachometers, and a self-recording barograph, these instruments being neatly arranged in the engine-room.

The auxiliary machinery includes a main lighting and power-generating set, illustrated in Fig. 4. It consists of a 60 brake horse-power single-cylinder Beardmore-Speedwell hot-bulb oil engine, which drives a 40-kilowatt 220-volt Laurence-Scott dynamo. This machine is of the protected type, and is constructed for a running speed of 300 revolutions per minute. The current generated is utilised for driving the main bucket elevator, the port and starboard pipe lifting winches, the winch for lifting the tee pieces, the deck capstans, the rotary air locks, and the belt conveyor arranged aft. The motors and control gear for these services were supplied by the British Thomson-Houston Company, Ltd., of Rugby. A Reavell starting-air compressor, driven by a paraffin engine, a bilge pump, a fuel oil pump, and a ventilating fan are also fitted.

FIG. 3—TWO OF THE EXHAUSTER UNITS

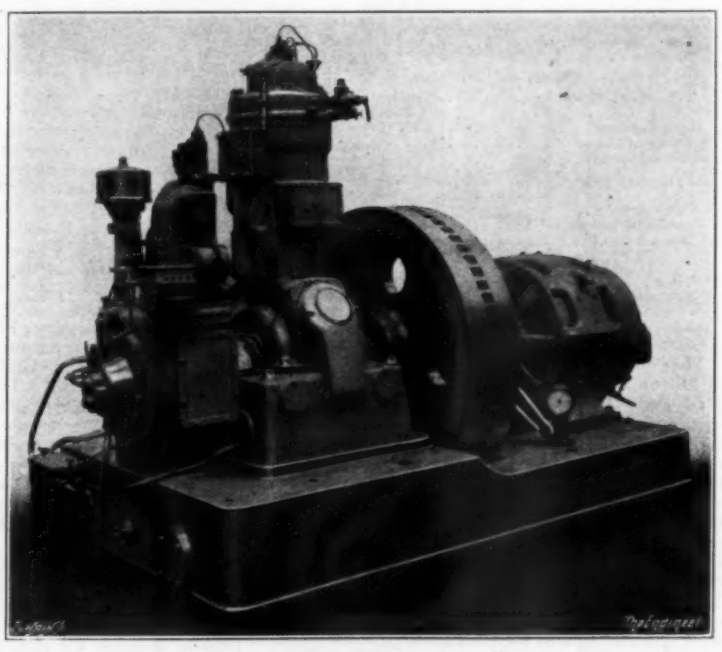


FIG. 4—60 B.H.P. AUXILIARY LIGHTING SET

TEST RESULTS.

By the courtesy of the builders and of the Port of London Authority, we are enabled to reproduce in Fig. 2 the results of a test trial which was made on February 28th and 29th last. The time during which the vacuum was broken for the purpose of changing or turning the lighters, and also when the weigh-house was full, is denoted by the mark X. We summarise the graphical results given in tabular form below:—

	Average duty.	Maximum duty.
Rate of discharge of grain in tons per hour	113.1	133
Brake horse-power of air exhauster	201	220
Brake horse-power of air locks	3.33	4.1
Brake horse-power of bucket elevator	12.30	14.3
Total brake horse-power for average duty	216.63 B.H.P.	
Average exhauster power, B.H.P. per ton per hour	1.75 B.H.P.	
Average B.H.P. per ton per hour, exhauster and auxiliaries	1.91 B.H.P.	
Fuel oil consumption per ton per hour	0.89 lb.	
Lubricating oil consumption per ton per hour	0.069 lb.	
Cost of fuel oil—at £6 per ton—per ton per hour	0.57 pence	
Cost of lubricating oil at 3s. 9d. per gallon, per ton per hour	0.34 pence	
Cost of running main engine only, per ton per hour	0.91 pence	
Cost of running main engine and auxiliaries, per ton per hour	0.98 pence	
Total cost of discharging grain, per ton	1.0 pence	

Since the above test was carried out, a fuel oil of a cheaper grade, bought in bulk at £3 10s. per ton, has been used, thus reducing the total cost for both fuel and lubricating oil to 0.7d. per ton.

An average figure for last year was, we learn, 40s. per day for the cost of fuel and lubricating oil, or approximately 4s. 9d. per 100 tons of grain discharged. Such results show a considerable saving when compared with the outputs and working costs of the steam-driven pneumatic grain elevators, which are working in the Port of London. These elevators discharge, we are informed, an average output of grain of from 80 to 90 tons per hour, and use about 5 tons of coal per day, which, at 26s. per ton, amounts to a cost of about 19s. per 100 tons of grain discharged.

Other advantages which the makers claim for the oil engine driven elevator are the saving on engine-room staff and quick starting. Only one engineer and two greasers are employed, as against one engineer, one greaser and three firemen in the case of the steam-driven elevators, and the plant can be ready for service within two minutes of the men coming on board.

In conclusion, we may refer perhaps to the experience gained with the plant. The makers inform us that it has given great satisfaction, and in operation has proved both economical and free from dust. The principle of returning the exhausted air to the small cyclone arranged at the top of the receiver has contributed towards making this type of elevator one of the most dust-free operating in the port. Again, it has been found that the average position of the grain suction pipes on the face of the receiver is at the second opening, enabling the plant to operate with the minimum lift.

Railway Matters.

ALL the electric lighting on the Great Western Railway is now in charge of the chief mechanical engineer.

WHEN on its way from Monmouth to Severn Tunnel Junction, over the Wye Valley branch, a passenger train was wholly derailed on Saturday evening last.

THE electrification of the railway between Stockholm and Gothenburg has advanced so far that trial traffic on the Falkoeping–Moholm section will probably begin in May.

THE deepening of the inner harbour at Holyhead, described in THE ENGINEER of August 1st last, has now been completed, and as from Sunday last passengers transfer to and from the boats at the station and not at the Admiralty Pier.

ABOUT the middle of next month the Egyptian State Railways Administration will be issuing specifications for the supply of 400 open goods trucks. Tenders will be accepted up to June 1st, 1925, for either 100, 200, 300, or 400 trucks.

THE original estimate for the electrification of the Maritzburg–Glencoe section of the Natal main line and the Howick branch was £2,962,800, but the later estimated cost was £3,852,334. An additional £927,655 for locomotives has been earmarked against the renewals fund.

THE Canadian National Railways during 1924 expended 1,650,751 dollars on the construction of branch lines, and the estimated expenditure for this purpose during 1925 is 8,766,585 dollars. The whole programme for the construction of branch lines involves the building of 548 miles of railway at an authorised expenditure of 15,186,000 dollars.

OF the three companies that formed the Southern Railway, only the London, Brighton and South Coast gave names to its engines. Now, however, many of the new engines under construction for the Southern Railway are to be named, and forty-four are to be associated with the Knights of the Round Table. One will bear the name King Arthur, and it will designate the class of the engines. The name plates will be in brass, with raised and polished letters on a dark green background.

THE chairman of the Great Western Railway, speaking at the recent annual meeting, said that it was no exaggeration to say that many branch lines did not pay, even when allowance was made for their contributive value to the rest of the system. The company's officers were considering ways and means of reducing costs of operating branch lines, but the time might come when some branch lines would have to be closed, and the places on them served by road vehicles operating from the nearest trunk line station.

THE latest poster issued by the "Underground" is a very striking one. It is an almanac, but instead of the usual figures of the days of the month, the 365 spaces are filled by symbols to characterise how each day's fares are spent. Thus, wages are represented by an open hand, and it is shown that 222 days' fares go in wages. Petrol is indicated by the familiar tin, and the calendar shows that 40 days' receipts are spent in petrol; whilst another 34 days' go in stores. In the end, only 13 days' receipts are available for the company to pay interest on its capital.

A PROPOSAL has been made and is receiving the attention of the authorities for the construction of a central railway station in Madrid. Great inconvenience and delay are caused to travellers by the fact that the six termini in the capital are not only far from the centre of the city, but from one another. The project put forward is to use the site at present occupied by the Plaza Mayor, a short distance from the most important thoroughfare in Madrid, the Puerta del Sol. From surveys already made, it is stated that it would be found an easy task to link up the three most important railway termini—El Norte, El Sud, and Las Delicias. A through underground station would thus be provided.

THE new Michigan Central Railway bridge at Niagara Falls has been completed and was opened for traffic on February 16th. The bridge is a combination of the cantilever and steel arch types, being erected as a cantilever until the lower chord was connected at the centre, when it became a two-hinged arch. There are two railway tracks and two footways. The arch measures 640ft. in length. The total weight of the structure is 6130 tons, and the cost, which is borne by the Michigan Central Railway, is 2,225,000 dollars, being 25,000 dollars below the estimate made by the company. The work was done by the American Bridge Company. The new bridge will enable trains carrying the heaviest loads to cross at high speed.

THE rival schemes of the London, Midland and Scottish and the London and North-Eastern companies for a railway into the "Dukeries" district of Nottinghamshire are of interest to the public in more ways than one. At the statutory meeting of the former company on the 3rd inst., several stockholders protested against the building of that line for both sentimental and business reasons, the sentimental reason being that it would spoil the beauties of Sherwood Forest and the business reason being that as the London and North-Eastern Railway was also promoting a Bill for the construction of a railway which would run parallel with the proposed London, Midland and Scottish Railway line, it would seem to be a wasteful expenditure of capital.

WHEN railway communication was given to Hastings and St. Leonards in 1851–52, the tunnels were made so narrow that the width of the carriages passing through Bo-peep and the other tunnels on the line to Hastings is limited to 8ft. 1in. across the body, instead of the normal 10ft. 9in. or 11ft. This is, of course, no new condition, but as most of the health resorts served by the Southern Railway have been agitating for a better service, Hastings has apparently felt that it must also be heard. A deputation from the Town Council there saw the general manager of the Southern Railway on the 3rd inst., and Sir Herbert Walker explained that the company's engineers are now engaged in surveying these tunnels with a view to widening them enough to take stock over 8ft. wide.

Notes and Memoranda.

IT is estimated that the total output of gold by the mines of the Witwatersrand, since their discovery and preliminary exploitation in 1886–87, up to the end of 1924 has been 804 million pounds sterling.

SIR ADAM BECK fears a power shortage in Ontario in 1926, and believes that the construction of a large steam plant is the only solution, as more water power development cannot be completed for over five years, even if sanctioned now.

ACCORDING to Major-General Patrick, Chief of Air Service, United States Army, two important problems in aeroplane design are the production of a variable pitch and a reversible propeller. The first is necessary for providing power in taking off and the second to act as a brake in landing.

ACCORDING to Sir Adam Beck, Chicago's abstraction of water from the Great Lakes for the dilution of sewage in the Chicago River entails a loss to both countries in the Ningara and St. Lawrence rivers of about 500,000 horse-power, which under reasonable circumstances of development from coal would be equivalent to an outlay of about 35,000,000 dollars per annum.

TESTS conducted at the American Bureau of Mines experiment station show that helium, when mixed with oxygen, forms a respirable atmosphere similar to normal air, and indicate that the use of helium-oxygen mixtures materially reduces the time of decompression, the process by which divers and compressed air workers are restored to normal air conditions after finishing their work.

IN the course of a paper on "Fuel Economy," read recently before the Institute of Marine Engineers, Mr. E. W. L. Nicol said that by using a mixture of coal and coke on the "sandwich" system for firing a boiler, an economy of 19 per cent. had been effected. On the sandwich system the coke is fed on to a chain grate-stoker as a thin layer, and the coal is spread as another layer above.

CARBON monoxide, the commonest and most insidious of poison gases, continues to kill thousands of human beings yearly. In New York City each year several hundred people die from carbon monoxide poisoning due mainly to lack of proper care in the use of illuminating gas. Records from the State Department of Health of Ohio, which are said to be incomplete, show that there were 64 deaths and 113 partial asphyxiations in that State during the winter of 1922–23. Fifty-five of the deaths were due to gas heaters and stoves and five to exposure to motor car exhaust gas.

THE commercial value of aviation is pointed out in the *Columbian Trade Review* by the following examples:—The journey from Girardot to Neiva takes four days on mule back, but only 70 minutes by the aeroplane service. The fast Magdalena boats leave Barranquilla on Mondays at nine in the evening, and under the most favourable circumstances arrive at Girardot eight days and nights later. When the river is low, this time is likely to be increased from four to eight days. The minimum time in which mail sent by boat can reach Bogotá is therefore 216 hours, against 30 hours for air mail, or a saving of nearly eight days by the latter, generally increased to nine or eleven days by delays to the steamer.

IN commercial carbon steels, the reduction of area increases, according to the *Iron Age*, generally with temperature but the changes are very small above 950 deg. Cent., and not of much practical importance. In alloy steels, the changes encountered with temperatures vary widely with the composition of the steel. However, a marked increase in reduction of area up to 600 deg. or 800 deg. Cent. is observed in all the alloy steels; at higher temperatures only a small increase, similar to that in carbon steels, is shown in the 2 per cent. chromium and 3 per cent. tungsten steels, while sharp decreases and minimum values are found in the neighbourhood of 1000 deg. Cent. for the 3 to 1 nickel-chromium and 2 per cent. silicon steels. This range of "reduced malleability," which is to be avoided in hot-working these steels, is followed by a rapid increase and high values of reduction of area at 1200 deg. Cent.

SPEAKING before the Past and Present Mining Students' Association at Wigan recently, Mr. G. H. Griffiths said that one of the factors in the destruction of a wire rope was vibration, and it was one of the most dangerous, as it was not easily recognised. When the load was taken by the engine, be there ever so little slack in the rope, a true and vibratory effect was set up between the winding drum and the load. Although the application of the lifting force to the load apparently occurred at the instant the engine was moved, in effect a series of vibrations was transmitted through the helicoid rope before the load was taken up. These ripples or waves of vibration concentrated at the end of the rope next to the capple and fatigued the wire, causing it to become brittle at this point. This could be seen when a portion of rope was cut off for re-cappling, and it would be sometimes found possible easily to break individual wires by hand, although the wires in the rest of the rope were perfectly tough and sound.

DURING a recent investigation conducted in the laboratories of Arthur D. Little, Inc., of Cambridge, Mass., on behalf of the Simplex Wire and Cable Company, of Cambridge, to find new ways to flame-proof insulated electric wire, it was discovered quite empirically, states the *Chemical Trade Journal and Chemical Engineer*, that selenium had great value. One part by weight of selenium protects 3.6 parts of cotton braid and 10 parts of rubber covering in the presence of 10 parts of copper conductor, constituting the usual No. 22 switchboard wire. Three milligrammes of selenium thus protect a centimetre of length of wire, or 1 lb. protects nearly a mile. The protection referred to is freedom from spreading of the flame along the wire held horizontally when the Bunsen burner, candle or other igniting agent is removed. This much protection is secured by the usual processes only when the wire is practically crusted with salts. On application of the flame much difficulty is experienced in getting the wire to ignite at all. When ignited, however, and the igniting flame is removed, the flame usually goes out without appreciable spreading.

Miscellanea.

BORING operations for coal are shortly to take place at Sutton, near Bawtry, to the south of Doncaster.

A NEW cement factory, with an initial output of a thousand tons a week, is to be built near Cambridge.

IT is proposed to install a manual common battery telephone exchange in Cairo for 6000 lines and an ultimate capacity of 8000 lines.

THE pig iron output of the Usina Siderurgica Belgo-Mineira at Sabará, in Brazil, last year reached 8253 metric tons, as against 6449 in 1923 and 3834 in 1922.

THE Cunard liner Saxonia, a ship of 14,197 tons, built at Clydebank in 1900, by J. Brown and Company, Ld., has been sold to a Dutch firm for breaking up purposes.

THE designs for the National Museum of Engineering and Industry, which is to be erected on the Smithsonian Institution in Washington, show that the building will be 1150ft. long by 200ft. deep.

ACCORDING to the *Iron and Coal Trades Review*, Mr. Schomberg, the Mysore geologist, has discovered deposits of coal in Kamasamndram, which may prove of benefit to the Kolar gold mines and the railways of South India.

THE chief engineer of the Hydro-electric Power Commission of Ontario recently announced that an expenditure of 12,000,000 dollars on transmission lines, generating plants and transmission stations was called for in the 1925 programme of the Commission.

ACCORDING to the *Deutsche Allgemeine Zeitung*, concessions to exploit mineral deposits in Anatolia and to build a new branch line of the Baghdad Railway have been granted to a group, backed by the Deutsche Bank and the Crédit National of Constantinople, which have undertaken to finance the working of copper mines at Arghana-Maden.

AT a recent meeting of the Aberdeen Association of Civil Engineers Professor Blackadder said that he was busy designing the buildings or the reconstruction that would form the engineering department of the University. He hoped that in his department they would be able next winter to begin the laboratories, and the following year to be fully equipped.

A MESSAGE from Rustenburg to the *South African Mining and Engineering Journal* states that a long belt of platinum has been found in that district. The belt is said to extend from Mamogales location, in the south-eastern corner of the Rustenburg district, in a westerly direction to Rustenburg itself, then north-west to Groenfontein, 302, and then north-east to Hakdoorndrift, 165, a total length of about 100 miles.

ON Tuesday, March 10th, a meeting of the special joint committee representing the Shipbuilding Employers' Federation and the Federation of Engineering and Shipbuilding Trades was held at Carlisle, when the question of an agreement for improved conciliation machinery in the industry was further considered. The negotiations were advanced a step further, and it was agreed that another meeting of the committee should be held at an early date.

THE Board of Trade has just issued a special notice to shipowners, marine superintendents, engineer superintendents, and marine engineers pointing out the danger which is run by having faulty water gauges on boilers. Instructions as to the proper testing of boiler water gauges are contained in the booklet "Regulations relating to the Examination of Engineers," which can be purchased (price 6d.) through any bookseller or directly from H.M. Stationery Office.

AN interesting event in the Yorkshire coalfield was the meeting underground, a few days ago, of the workers of the Bullcroft Main Colliery, owned by the Markham group, and of the Bentley Colliery, owned by Barber, Walker and Company. It had been known for some weeks past that the miners of the two collieries were working toward each other, and communication was recently established between the men, and coal was got right up to the boundary. It was carried out without a hitch, and coal getting will now proceed in the ordinary way, the men of the two collieries working away from each other, and filling in as they proceed. The event is unique in local mining.

A REPORT from Prague states that all the European magnesite works have formed a Cartel for the production and sale of magnesite. The leading spirit is the Veitsch Magnesite Company, of Vienna; other works included in the Cartel are the Magnesite Company of Pressburg, the Radenstein concern owned by an American group, the Styrian Magnesite Works at Eichberg and Aue, the Weissenberg Works at Breslau, the Stella Works at Ratibor and Beuthen, the Eglinton Magnesite Brick Company, Limited, of Glasgow and London, and the West Bohemian Kaolin and Firebrick Company in Prague. The works included in the Cartel control 99 per cent. of the European output.

AT a recent meeting of the Walsall Town Council, a report of the Electric Supply Committee was presented by Mr. Thickett, who said that in view of the continuous and remarkable progress made by the undertaking, a general reduction of the charges for electricity had been decided upon, and would come into force at the end of the present quarter. He added that the council could congratulate itself on the fact that none of its charges were more than 20 per cent. above pre-war prices, which in view of the abnormal circumstances was something to be proud of. Mr. Parry, who seconded the adoption of the report, said that it was to be hoped that the concessions which had been made would have the effect of increasing the use of electricity for domestic purposes in a large number of houses, as in certain circumstances current would be supplied at a penny per unit, whilst big consumers of power would get their current at something like ¼d. per unit. What the committee wanted was a larger output. At present the undertaking was producing electricity at a lower cost for generation than any other undertaking in the West Midland area, but the comparative cost of the standing charges placed it at a great disadvantage. If the output could be doubled the standing charges would be reduced considerably.

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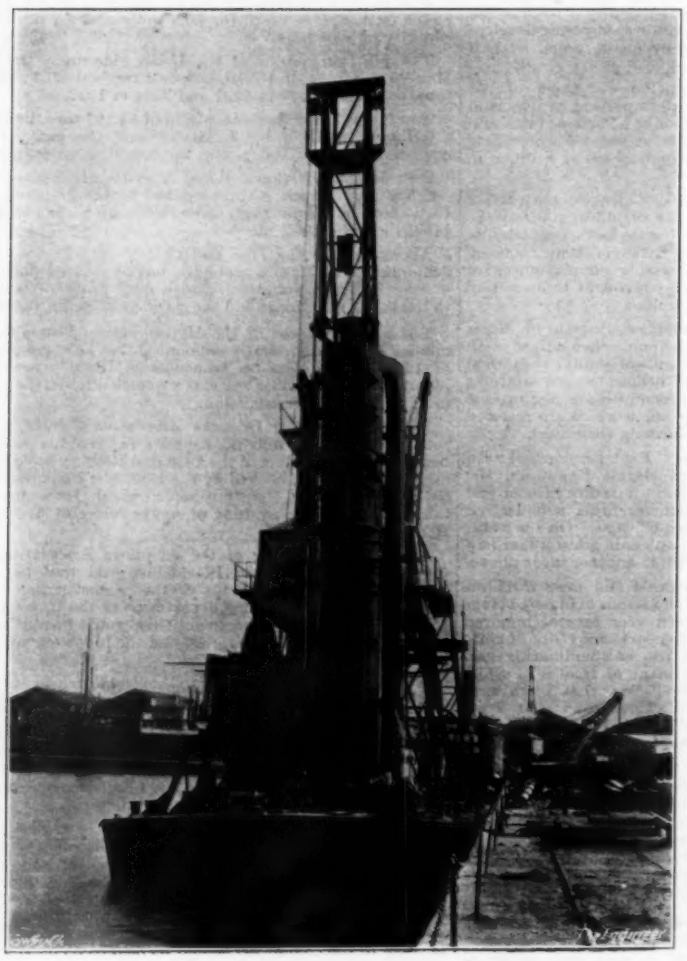
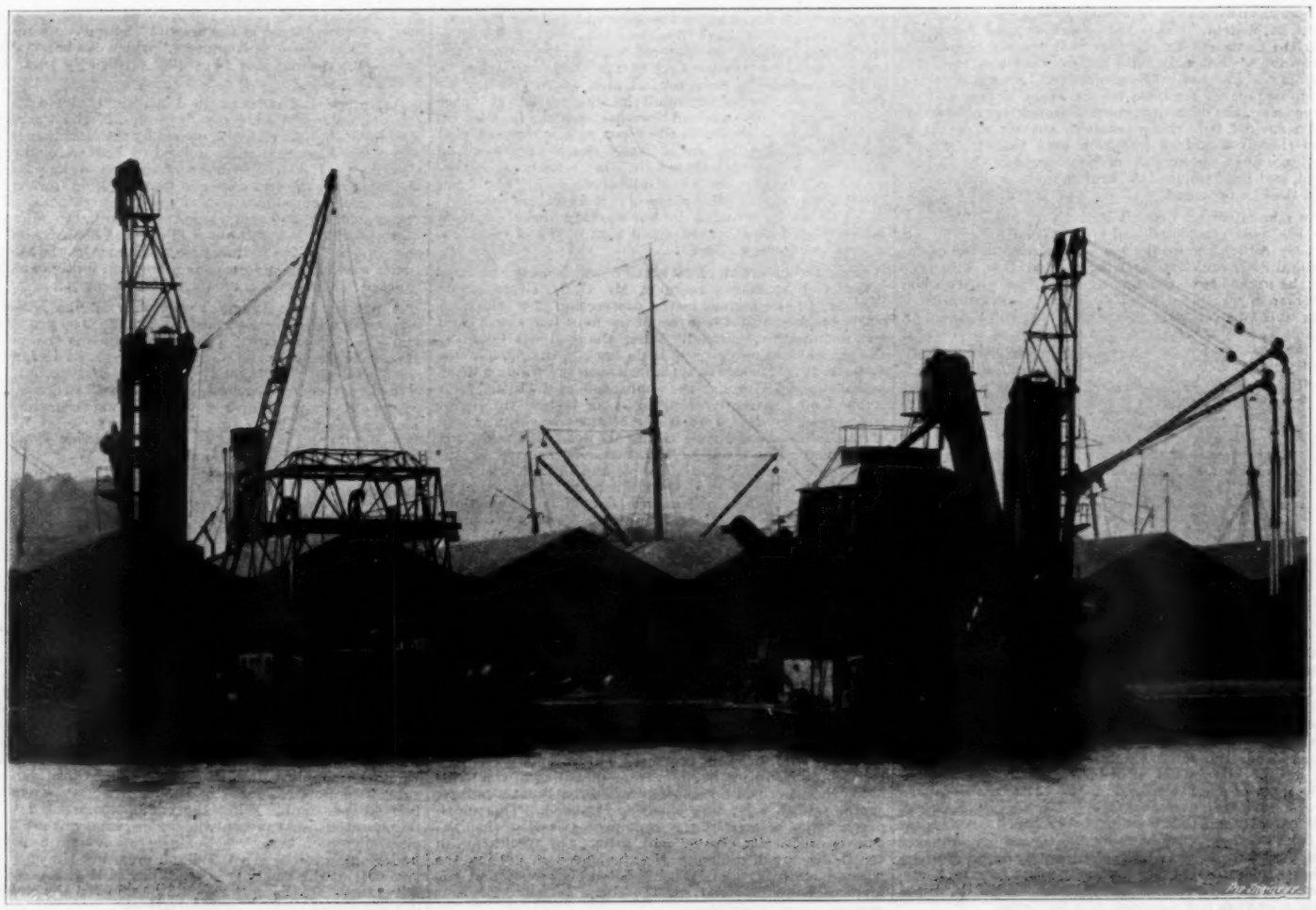
(*For description see page* 297)





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DEATHS.

On the 6th March, suddenly, GUSTAVUS FERDINAND BONNOR, M. Inst. C.E., M.I.E.E., M.I.M.E., 4, Pembroke Villas, Richmond Green.

On the 9th March, at Great Buckmans Farm, Leigh Sinton, WILLIAM MAYLOR, A.M. Inst. C.E., eldest son of the late William Maylor, M. Inst. C.E., M.I.M.E., aged 64 years.

THE ENGINEER.

MARCH 13, 1925.

The State of British Shipbuilding.

THE announcement that orders for five motor ships have been placed by the Furness-Withy group with the Deutsche-Werft, a modern German shipbuilding company, has come as a shock to a country which has hitherto not only supplied all its own needs in shipbuilding, but has built about 20 per cent. of the ships belonging to foreign owners. The plight into which British shipbuilding had fallen was known all too well by those connected with it, but it required some such overwhelming evidence as the placing of this order to bring it home to the country at large. The announcement has been followed by widespread discussion in shipbuilding circles, in the Press, and even in Parliament. At first there was a tendency to accuse the Furness-Withy group of unpatriotic action, but when the actual figures were more closely considered the justification of its action became manifest. Tenders were sought in Belfast, on the Clyde, and on the North-East Coast. The lowest figures from any one of these centres amounted to £230,000 per ship; the German quotation was £170,000 per ship. The difference of £300,000 on the total order was too great to be disregarded, even on patriotic grounds, and dwarfed into insignificance the £50,000 more than the lowest German tender which the owners were prepared to give British shipyards if they would accept the order.

For various reasons, on which public attention has now been concentrated, shipbuilding costs in the yards of Great Britain and Ireland have reached a very high level. It has been stated, indeed, that had the whole of the wages bill for the construction of the hulls of the five ships now contracted for in Germany been eliminated, no British shipbuilder could have quoted for the contract with any chance of success. The shipowner has been placed in an awkward dilemma. He can order ships from home yards at what he regards as uneconomic prices; he can carry on with his existing fleet, some units of which are admittedly in the obsolescent stage, or he can place orders abroad. He has, so far, resisted valiantly the temptation to fill his requirements in foreign yards. It is true that a good deal of repair work has gone to Dutch establishments and that one or two orders for new tonnage have been placed in Holland, but the loss of this work has been tempered by the knowledge that the Dutch industry is to some extent financed by British capital and that the *personnel* is partly British. No such "flattering unction" can soothe our chagrin in the present case. The contract which has been placed in Germany must be accepted as providing definite proof that at the present time the British shipbuilder is unable to offer effective competition with German yards. These establishments and other continental yards have already deprived home shipbuilders of many orders from foreign shipowners, which in pre-war years represented 20 per cent. of the total British output; but the invasion of the home field is the last straw. In the attempt to bottom the reasons for the very low tenders submitted by German yards a wide field of inquiry has been opened up. Some of the facts which have been made public during the past week have been common knowledge for a long time past to those who are familiar with shipbuilding conditions at home and abroad. It is known, for example, that the German employer pays somewhat lower rates of wages than British shipbuilders, that the working week in German yards is some hours longer, that many of the trades union restrictions, which add to the cost of work in Great Britain, are absent, and that there is a general willingness on the part of the workers to co-operate with employers in reducing production costs to a point at which work can be obtained. It is known also that the percentage of skilled to semi-skilled and unskilled men in German establishments—and in Dutch yards as well—is lower than in British establishments, and it is obvious that this dilution of labour must have an appreciable effect in reducing the wages bill. It is certain, too, that German shipyards have the advantage of cheaper shipbuilding material than British yards, and, indeed, it was stated by Mr. McLean, the Labour member for Govan, in the House of Commons on Tuesday, that iron and steel plates manufactured in Great Britain are sold abroad at 30s. per ton less than the price quoted to British yards. Another Labour member of Parliament, Mr. Connolly, who is himself an old shipyard worker, directed attention in the House of Commons on the same occasion to some of the other factors which have entered into the placing of orders for British ships with German firms. He pointed out that the German shipbuilder is able to obtain loans free of interest for a period of three years, that subsidies to the amount of 30 per cent. are contributed by German municipalities, and that this assistance is augmented by a contribution from the State, representing 50 per cent. of the wages paid. On its side the British industry, hampered by the difficulties and restrictions to which we have already referred, has to bear an extremely heavy burden of taxation and rates. Mr. Connolly stated that local rates in some shipbuilding districts had risen to a point 22½ times above that at which they stood in the year 1914. In other areas the local rate, which was 12s. 6d. per workman in 1914, is £2 8s. at the present time. This comparison of the difference in British and German conditions—and there are other factors which might be taken into account—explains the difference of at least £6 per ton in the tenders submitted by British and German yards for the Furness-Withy contract. There is the further consideration that in the desire to obtain the contract the successful German firm quoted a closely cut figure. It has been suggested, not for the first time, and the Prime Minister has put the suggestion into concrete form, that an inquiry in which both employers and employed would take part should be made into the conditions which permit the diversion of orders from this country to foreign competitors. Mr. Connolly, who represents a Newcastle constituency, has expressed his willingness to discuss the position and to assist as far as he is able to to put that great British industry on its feet. Sir George Hunter, in recent contributions to the subject, has invited the co-operation of the workers, and he has pleaded many times for a more sympathetic attitude on the part of trades unions in dealing with questions of working hours and conditions of labour. The need of co-operation has not, however, been overlooked by shipbuilding employers. At the present time a joint committee of the Shipbuilding Employers' Federation and the Federation of Shipbuilding and Engineering Trades is holding a series of conferences—the last took place on Tuesday at Carlisle—with the object of evolving improved conciliation machinery, and it is hoped that the next stage of the work, which is making satisfactory progress, may be a consideration of the offer made by employers to work out in co-operation with the trades unions a scheme for the automatic regulation of wages and generally to

promote harmonious relations between employers and employed. It would only need an extension of this movement to bring under review the whole subject of hours and working conditions, and it is hoped that this may be the outcome of the proof now given that reforms which, without reducing wages, would bring about a decline in cost of production must be effected in the shipbuilding industry. It is true that within the past few weeks the shipyard unions have made applications for increases in rates of wages, but they have been definitely refused by employers, and it is hardly conceivable, in the light of the latest developments of the situation, that they can be persevered with. The hope is rather that a joint inquiry into the whole position will be undertaken and means found for bringing about a revival in an industry in which Great Britain has, until now, occupied a position of absolute predominance.

As an immediate remedy it is suggested that a number of ships should be built with financial guarantees under the provisions of the Trade Facilities Act, and Mr. Howden Hume, the president of the Institution of Engineers and Shipbuilders in Scotland, has, in a letter addressed to *The Times*, pressed on the Government the need of providing work in the shipbuilding and allied trades by undertaking the maximum quantity of warship construction permissible under the terms of the Washington Treaty. If these plans are adopted a temporary stimulus will be given to shipbuilding, but the malady from which the industry is suffering, that of high production costs, will not be touched. A correct diagnosis of this disease and the application of sound remedies is what is needed, and concentration on this task must not be retarded by the employment of palliatives.

Automatic Telephones.

Telephone engineering is a wonderful business, which few save those who are intimately connected with it appreciate or understand. Most of us use the telephone without giving a thought to the intricate nature of the system or to the ingenuity of those who have been responsible for its development. There is now no dearth of telephone literature, but the technical side of the subject does not create widespread interest, and many who are engaged in the more modern branches of electrical engineering have little knowledge of this older but no less important branch. In a newly published book on the "History of the Telephone in the United Kingdom," Mr. F. G. C. Baldwin explains that in the early days of telephony, when master patents were in force, an atmosphere of extreme conservatism and exclusiveness was created, and officers of the United Telephone Company were even denied the privileges accruing from membership of the Institution of Electrical Engineers, and were actually forbidden to attend the Institution's meetings. On account of the patent situation and the legal considerations arising out of the possibilities of infringement, telephone engineers were not free to divulge information, with the result that during the period the company operated, viz., from 1880 to 1889, very little telephone literature was published. But telephone engineers are no longer required to avoid meetings; indeed, no meetings of that Institution are better patronised than those at which papers on telephony are read, especially when the author happens to be the Chief Engineer of the Post Office. When Sir William Noble read his paper a few years ago, the large lecture hall of the Institution of Electrical Engineers proved inadequate for the occasion, and a similar state of affairs prevailed last week when a paper on "The Post Office and Automatic Telephones" was read by the present Chief Engineer, Colonel T. F. Purves.

For more than fifteen years, it seems, the Post Office has studied the development of automatic exchanges very closely by giving an actual working trial to various systems which seemed likely to be capable of providing a good and reliable public service. There are now twenty-six exchanges of various kinds in operation, all of which have given and are still giving satisfactory results, and have served to demonstrate that the automatic method of working is acceptable to the general public. Investigation has also shown that, as a rule, when a change from manual working is justified, the full automatic system presents a greater balance of advantage than the semi-automatic system. But although it has long been recognised that the mechanical switching possibilities of automatic selecting are theoretically unlimited, there have been practical difficulties in the way of applying it to the telephone service of the largest area systems which have grown up in the manual exchange practice. In his paper Colonel Purves describes these difficulties, but it will suffice to say here that four years ago the London Post Office was eager to start the introduction of automatic telephones in London, as many new exchanges were required to provide for development, and for the replacement of existing obsolescent or inadequate exchanges. After careful consideration, the so-called "panel" system was chosen for the London area, but in consequence of subsequent developments the negotiations which were in hand for the introduction of that system were broken off. During these negotiations the sponsors of the step-by-step automatic systems introduced certain improvements, which in 1922 led Colonel Purves to recommend the adoption of the step-by-step system, with the addition of a director. This "director system," it seems, contains all the essentials required as a basis on which to frame a complete equipment of circuits and apparatus admirably fitted for the service of such an area as London. One of the reasons which the author gives for the final selection of this so-called "director system" is that the fundamental electrical plan is very much more simple than that of the panel system, but it is doubtful, in our opinion, if the word "simple" should be applied to automatic telephones at all. The fact remains, however, that after very careful consideration the Post Office engineers have come to the conclusion that this particular system is the best for large areas. An appendix to the paper shows that an appreciable development in automatic telephones is imminent. No fewer than 161 automatic exchanges with a capacity of about 368,000 subscribers' lines are to be erected. Thirty-two of these exchanges will be in London, whilst the remaining 129 will be erected in the provinces.

Some telephone subscribers, we assume, can therefore look forward to a rather better service than that which has been provided in the past, for assuming that the apparatus always does its job, there should be fewer mistakes. The subscriber who gets an incorrect number will, we take it, have the satisfaction of knowing that it is his own fault. For the imperfections of telephone working the Post Office usually gets all the blame, although it would appear from the remarks of a speaker at a recent meeting that it is really the public that is at fault! The public, he said, had never learnt to use the telephone. When a subscriber lifted the telephone receiver from its rest, this speaker asserted, he could never be relied upon to replace it, and in order still further to emphasise the imbecility of the telephone user, he cited the case of a business man who engaged a new office boy. When asked if he could use the telephone, the lad replied that he could not, and his employer then proceeded to explain that all he had to do was to place the receiver to his ear, and when he heard someone say, "Are you there," to reply "Yes" or "No," as the case might be! There is no doubt that telephone officials sometimes get more blame than they really deserve, and it is only natural that they should retaliate when they get an opportunity. The automatic system should, however, serve to remove some of the existing troubles and in many cases to reduce the working expenses.

Association of Technical Institutions

Several of subjects of interest to engineers were under discussion at the annual meeting of the Association of Technical Institutions, which was held at the Institution of Mechanical Engineers on March 6th and 7th.

Lord Montagu of Beaulieu, the incoming President, in an address, referred to the prejudice which existed against those who worked with their hands. When he first entered the railway workshops at Nine Elms his action was regarded as eccentric, and when he went out on the road and drove a locomotive, he was told that it was a thing not done by any gentleman! The technical ignorance of the general public on the simplest subjects was appalling. The average householder did not know how to mend a tap or even to adjust the register of his fire-place or put the lock of a door in order. He did not deprecate the value of secondary education, but technical education was of the greatest importance, and it should be directed into the right channels. It was clear that the steam engine was being superseded by the internal combustion engine. That type of prime mover would in future dominate the field of road transport, and would be the common method of ship propulsion. These tendencies were evident, but in many technical institutions far more attention was still being given to the steam engine than the internal combustion engine. He desired to emphasise the need of keeping education out of the political arena. Unless that were done political opinions would begin to colour a considerable portion of the teaching, and the schools would become the cockpit of rival politicians.

Technical Education.

A general discussion on the present position of technical education revealed certain defects of the existing system.

Principal W. Munn Rankin (Burnley) commented on the lack of any effective link between the elementary and the technical school. The continuation school did not supply the right kind of connection, as, while a large number of students passed from the elementary to the continuation school, the number who became students at the technical schools on leaving the continuation course was comparatively small. Other influences were now at work. An organisation for the education of the workers directed by the regional universities was in operation, but was not connected with other educational influences. Political parties were also engaged in the provision of instruction on economics of a non-party character, it was true, but neither this work nor the quasi-university system was to the real advantage of the community. In his opinion the time was opportune for a review of the present situation of technical education. With regard to the relation of this type of education to industry, he felt with others that there was a lack of the right kind of facilities for junior students in municipal colleges. The more advanced student was provided for by instruction in evening classes. At the same time, it had to be confessed that the activities of technical colleges had not been arranged to the extent necessary to meet the requirements of local industries. On paper the link between these colleges and local industries might appear to be of the right kind, but judged from the practical standpoint it was not so in fact.

Principal F. J. Harlow (Wigan) dealt with some of the same points. He thought that a link with industry was being forged by the various research associations which were now at work. At the present time a committee in Manchester was engaged in a consideration of improving the relations between education and industrial requirements, but nothing had been done to secure the assistance of the Association of Technical Institutions. He hoped the Council would take steps to assist the work of that committee.

Lord Emmott thought the overlapping of facilities was inevitable in the field of technical education. At the present moment an Advisory Committee of the Board of Education was giving special attention to the difficult problem of the education of boys of between fourteen and sixteen years of age. Then there was the question of junior technical schools, and it was a remarkable fact that students in those schools were often in advance of those in secondary schools. There was an increasing tendency which was being assisted by the Board of Education to give manual education in secondary schools. He noted that technical colleges were liberalising the technical education given. It was necessary to-day to teach in an impartial way the fundamentals of economics and history, even if these subjects brought the student into contact with political controversies.

A resolution was adopted to the effect that the time was ripe for a new survey of the relationship of technical education to the other organised systems of education and to industry. An addendum to this resolution gave expression to the satisfaction created by the steps already taken by the Council of the Association in this connection.

Local Colleges.

In presenting the case for local colleges, Lord Emmott said that the present educational areas were not the best for the purpose. The local college should serve the requirements of an area containing a population of 250,000 or more. The difficulty of bringing into being a new and better educational area lay in the disturbance of local vested interests created by previous legislation. The smaller elementary areas ought to be merged in larger areas, but it would be a serious thing to interfere unnecessarily with the financial powers of counties and county boroughs. It was clear, however, from past experience that the optional powers of amalgamation and co-operation were hardly ever used. Such powers were contained in the Act of 1902 and in the Act of 1918, but they had borne very little fruit. He was almost driven to the conclusion that compulsion of some sort was necessary. The most serious difficulties would arise with the County Councils. Some of them were very large. But provided the County Councils themselves retain financial control, it ought not to be a very difficult matter to induce the large ones to divide themselves into two or more educational areas of a size suitable for the creation of local colleges. Any reorganisation of secondary and technical education, and even of elementary education as part of a connected chain, ought to be undertaken in close consultation and co-operation with the authorities of any university or universities interested in the areas affected.

Certificates in Engineering.

The statistics given by Mr. J. E. Montgomery concerning the working of the schemes for national

certificates and diplomas in engineers were noted with much interest. The scheme which has been in operation for three years has been carried out by the Institution of Mechanical Engineers in connection with the Board of Education. The examinations, which are open to students following approved courses in technical colleges and schools in England and Wales, have given the results shown in the following table :—

	Mechanical engineering.			Electrical engineering.
	1922.	1923.	1924.	1924.
Ordinary certificate :				
Certificates awarded ..	521	606	564	282
Percentage of successes	51	53	51	68
Higher certificate :				
Certificates awarded ..	69	122	166	43
Percentage of successes	65	66	69	69
Ordinary diploma :				
Diplomas awarded ..	38	38	40	9
Percentage of successes	40	66	73	53
Higher diploma :				
Diplomas awarded ..	16	30	31	5
Percentage of successes	50	65	84	100

In 1923 the Institution of Mechanical Engineers arrived at an arrangement with the Scottish Education Department for the award of National Certificates and Diplomas in Mechanical Engineering to students at Central Institutions and Continuation Class Centres in Scotland. Certain courses have recently been approved under this scheme, and the first awards will probably be made during the present year.

A further step in co-operation between professional institutions was taken during the past year, when an arrangement was concluded between the Institutions of Mechanical and Automobile Engineers for endorsement on behalf of the latter Institution of Higher National Certificates and Diplomas in Mechanical Engineering in respect of automobile engineering subjects included in the final examination.

Position in America.

The concerted effort towards improvement in engineering education now being made by the colleges of engineering and technology in the United States and Canada was dealt with in a contribution by Mr. William E. Wickenden, director of the Society for the Promotion of Engineering Education. He said that all divisions of higher education in America which prepare for the scientific and learned professions were passing through a period of profound readjustment and the whole subject was being studied by the Society he represented. The relatively small part which engineers had taken in the public life of the American nations, and the limited influence which the profession as a whole exerted in matters of public policy, was beginning to be deplored. It was also felt that engineers should aspire to a larger share in the administration of great industrial enterprises where they had hitherto been overshadowed by lawyers and financiers. These aspirations would seem to call for a broader and more statesmanlike form of education, but it was equally recognised that America could not hope to produce great administrators by sacrificing the competency of technicians and scientists.

Decline of Apprenticeship System.

The conditions of training and education of apprentices was the subject of a paper by Mr. G. Mavor (Loughborough College). He said that the Council of the Association had endeavoured to organise a plan for the re-introduction of the apprenticeship system.

The change from the domestic to the factory method of production revolutionised conditions of apprenticeship. Restrictions on the number of apprentices employed had existed under the guild system, and under the domestic system the numbers were necessarily limited by the space available. In engineering, by far the largest field in which apprenticeship once prevailed, the system had practically gone out of use, and the restrictive barriers which once existed were being gradually swept away. The millwright of the last century was an itinerant engineer and mechanic of high reputation. What the millwright did with hammer and file was now broken up into innumerable separate operations, each of which had its own appropriate machine. But in addition the distinctive feature of the introduction of machinery into the engineering trade was the remarkable variety and diversity of power-driven tools required. The precise degree of skill and trustworthiness required to work each of the machines or even to execute different jobs on the same machine was infinitely varied. The simple drilling machine or the automatic lathe turning out identical copies of some minute element of a machine or engine could be tended by a mere boy, whereas some of the work on an elaborate milling machine required the whole skill of the most accomplished mechanic. The demand of modern industry was for specialisation, and, with the further developments of jigs and tools for mass production, the old-time skilled mechanic who required a seven years' apprenticeship would disappear.

What suggestions could be offered ? The greatest evil under modern industrial organisation was, broadly speaking, that the youth of the country was passing through the years of adolescence, without supervision, without efficient technical training, and therefore unable to accept opportunities of future progress when manhood was reached. With the universal employment of machinery and the continuous progressive subdivision and specialisation, industry, on the whole, was full of "blind-alley" occupations which offered comparatively high initial wages, but little or no possibility of permanent future employment. The condition was grave, and required immediate and comprehensive measures of reform.

As a first step, the school-leaving age should be raised to at least fifteen or possibly sixteen. Secondly, on entering industry, educational training should continue. The failure of the Fisher Act demonstrated that industry as a whole was not in a position readily to allow part day-time instruction to its employees. Experience showed that action on the part of the education authority, in co-operation with local employers, in providing evening education, had met with limited success, as the numbers in attendance formed a comparatively small proportion of the total number engaged in industry. The difficulty was how to control and continue the education of the rank and file between the ages of fifteen and eighteen. The ideal was definitely part day-time education, and where firms had already made such provision, either by co-operation with the local education authorities or by setting up their own trade school, every encouragement should be given to continue this system. In all other cases attendances at suitable evening courses should be made compulsory until such time as a better scheme may be introduced. The aim was to develop an alert, intelligent and self-reliant citizen and to incorporate that with teaching which would bring the boy into intimate contact with the needs of modern industrial organisation. Finally, by continued part-time education up to the age of eighteen, the boy would have a general understanding of the history and organisation of his trade and a broader knowledge of its technical requirements. He would thus be in a position more readily to adapt himself to changing conditions, and if no prospect were offered in one branch of his trade he would at least have considerably more hope of becoming efficient in another branch, and his general education would be sufficient to allow of further specialised technical training.

The whole problem was vast and of national proportions. Local action alone was futile, and improvement could only be secured by State action resulting from legislation. Before the latter was even possible, those responsible for the control and direction of industry must recognise the necessity for a more highly trained working force from which the competent "warrant officers" essential for future industrial progress might be drawn. That would mean some apparent sacrifice on the part of employers and an increased cost to the State, but would undoubtedly lead to greater industrial efficiency, since the scope for material progress lay primarily with better organisation. If nothing were done, Great Britain would be left behind by her trade rivals. Both German and American employers were demanding, and helping to provide for, a higher standard of educational equipment in the young people entering and within their industries. Only intelligent, active and sympathetic interest from the employer, supplemented by continued assistance from associations such as theirs, would give the State the necessary support and encouragement to carry through and put into operation the legislation necessary for the purpose.

Literature.

Die Kondensation bei Dampfkraftmaschinen. By Dr Ing. K. Hoefer. Berlin : Julius Springer, Linkstrasse 23–24. Price 22.50 gold marks.

The purpose of Dr. Hoefer's book is to give an account of the many improvements relating to condensing plant practice which have been made during the last fifteen years, but which had not been published in connected form in current technical literature. The work the author set himself to accomplish has been well done, and the book is illustrated by a large number of diagrams, tables, and drawings, so that a full and concise account of recent condensing practice in Central Europe is given. The first chapter deals with basic theoretical principles and the measurement of air in condensers. A few introductory pages on the choice of a condenser leads to a long chapter on jet condensers. The amount of cooling water required and the size of air pump for the parallel and counter-current systems are discussed and examples are given of modern jet condensers, which include several of the Leblanc type, others of the barometric type, special condensers for varying quantities of steam, and ejector condensers of the Körting, Leblanc and Rees-Roturbo patterns. In his treatment of the surface condenser Dr. Hoefer rightly devotes considerable attention to a mathematical analysis of temperature conditions and heat transmission ratios, in which the latest research work of Nusselt, Soennecken, Weighton, and Josse is reviewed. Another important section of this chapter is that devoted to tube corrosion, in which the theories of the Corrosion Committee, Lasche and von Wurstenburger are set forth, and measures to be taken for the prevention of corrosion discussed. Constructional details of surface condensers are given as well as several different examples of surface condensers designed for land and marine work. The atmospheric condenser is briefly touched upon.

Another important chapter is that dealing with the air pump, in which various continental types of wet pumps, dry pumps and steam ejector air pumps are described at considerable length. The design of steam jet air pumps is considered at some length, and test figures for various types of continental pumps, which include those of the author's own design, are reproduced. Some interesting figures on the comparative performances of different types are included in a special chapter devoted to this subject. The design of circulating and condensate pumps is only briefly dealt with, but an important chapter is that dealing with the theory and design of cooling plants and water cooling towers. In the concluding chapter some interesting tabular results of turbo-generator surface condensing installations of different types are given, together with relative costs of the condensing plant which are compared with the costs of the turbine and generator.

A valuable feature of Dr. Hoefer's book which should prove of especial interest to British readers is the lengthy bibliography of papers and technical articles dealing with condensing plant and air pump design. Although British practice is referred to from time to time in the book, and the work of British engineers is not altogether overlooked, the record deals mainly with the progress made on the Continent, and as such a record it may be of considerable use to students, engineers, and manufacturers of condensing plant. We put forward the suggestion that there is room for a similar work to Dr. Hoefer's which would deal fully with the progress made in Great Britain over the same period.

Radio : Beam and Broadcast, its Story and Patents. By A. H. Morse. London : Ernest Benn, Limited. Price 12s. 6d.

From a historical point of view this book is of interest and should prove of value to would-be inventors. As the author says in the introduction, within the last few years the radio field has been invaded by many thousands of persons who know nothing of the evolution of wireless, and are, therefore, sometimes unable to distinguish between what is new and what is old. As a natural consequence, they often waste much time and money in re-inventing old devices, and one of the author's objects is to correct the perspective of these newcomers. The evolution of the wireless art is traced mainly through the Patent Office records of inventions in use to-day. An interesting piece of information given in the introduction to the volume is that when anyone in America applies for a perpetual motion patent, the United States Patent Office requires the inventor to provide a working model of the apparatus.

In the first chapter the author endeavours to deal, in chronological order, with the discoveries and inventions which are more or less strictly relevant to the present state of the art, omitting those which have had no important practical application. This chapter, which takes up fifty-five pages, deals with developments up to 1912, whilst the next chapter is devoted to progress after 1912.

The author then considers the future, and expresses the opinion that it seems unlikely that there will be any great improvement in results, but rather in the methods of obtaining them. Beam signalling, he considers, will undoubtedly meet with extended use, and being presumably free from vital patent restrictions, is sure of rapid development, particularly for short distances. Other sections of the volume deal with the Poulsen arc, broadcasting, the triode as a generator, beam and short-wave radio.

In a concluding chapter, Mr. Morse says it is a pity that someone did not give to Hughes the encouragement and facilities for practical experiment which, nearly twenty years later, the late Sir William Preece gave to Marconi ; but it is, of course, to be remembered that the need of a wireless telegraph system was probably not so urgently felt in 1879 as in 1896, when Mr. Marconi was introduced to Sir William Preece by Mr. Campbell-Swinton.

In an appendix, which is composed of as nearly as many pages as the book itself, specifications of British and American patents or abstracts therefrom are given with a view to showing the most important steps in the evolution of radio communication.

BOOKS RECEIVED.

Fiume Tevere—Idrometro di Ripetta. Pubblicazioni del Servizio Idrografico. Rome : Libreria Dello Stato. Price 15 lire.

Vorschriften für Eisenbauwerke Deutsche Eisenbahn-Gesellschaft. Berlin : Wilhelm Ernst und Sohn, Wilhelmstrasse, 90. 3 gold marks.

Jahrbuch der Drahtlosen Telegraphie und Telephonie. Twenty-fifth volume. Berlin : Verlag von M. Krayn. Half-yearly subscription 15 gold marks.

Building Construction Plates. Parts I. and II. By A. Buchanan and W. H. Hudson. London : B. T. Batsford, Limited, 94, High Holborn, W.C. Price, Part I., 5s. ; Part II., 5s. 6d.

The Economic, Financial and Commercial Conditions in the Dominican Republic, by Darrell Wilson ; and *The Republic of Hayti,* by J. E. M. Carvell. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. net.

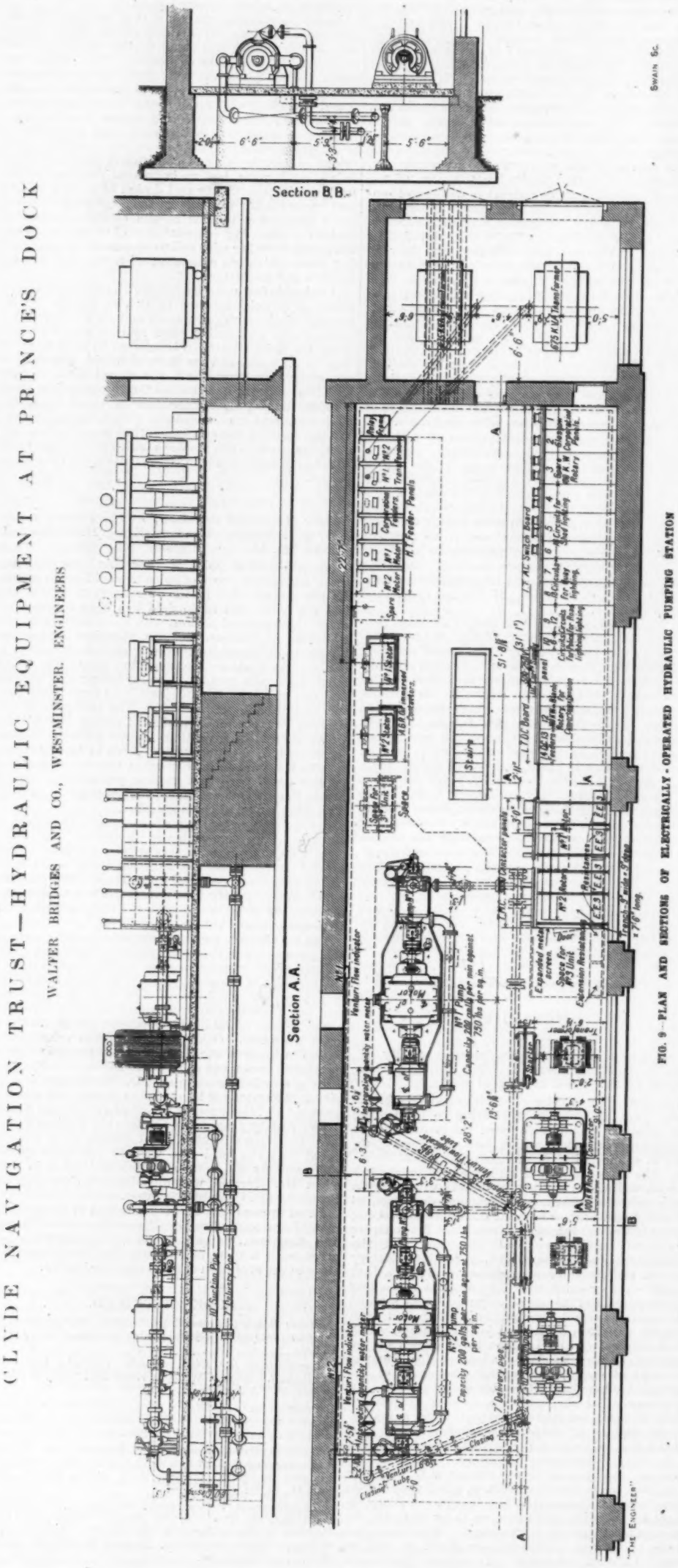


FIG. 9—PLAN AND SECTIONS OF ELECTRICALLY-OPERATED HYDRAULIC

New Dock Equipment on the Clyde.

No. III.*

THE HYDRAULIC POWER SERVICES FOR PRINCE'S DOCK AND THE GRAVING DOCKS.

THE original hydraulic pumping plant for supplying power to operate the various hydraulic cranes and other apparatus at Prince's and the Graving Docks was steam driven. It consisted of four marine type boilers supplying steam to four triple-expansion vertical steam engines combined with three-throw vertical type plunger pumps.

In order to ascertain the exact condition and efficiency of this steam-driven plant, Messrs. Walter Bridges and Co. were called in to report, in conjunction with the Mechanical Engineer to the Trust, and an exhaustive series of tests was carried out by them to provide accurate data on which to base their recommendations for an up-to-date plant to give more efficient operation. Several alternative schemes were then considered, with the object of ascertaining the most suitable plant to install, and eventually the alternative of replacing the steam plant with an entirely new electrically driven plant was investigated upon under two headings :—

(1) Using electrically driven reciprocating geared plunger pumps.

(2) Using direct coupled electric turbo-pumps.

The consulting engineers ultimately decided to recommend the replacing of the existing steam plant with electrically driven turbo-pumps, the motors being supplied with current direct from the Glasgow Corporation's high-tension alternating-current mains at 6600 volts.

Their reasons for this recommendation were (*a*) that the efficiency of automatically operated modern turbo-pumps is equal to, and under certain conditions higher than, that of reciprocating geared plunger pumps, and (*b*) further, they were cheaper in prime and working costs on account of (1) lower consumption of oil and engine-room stores ; (2) repairs not being so heavy ; (3) the foundations being considerably cheaper than for other types of plant ; (4) there being more uniform capacity efficiency on account of the absence of packing glands, valve slip, &c.; (5) because the turbine type of pump is elastic in automatically accommodating itself to conditions of fluctuating loads, has low starting torque, is simple in construction, has a small number of wearing parts ; and (6) because no reduction gear would be necessary and a large space in the engine-room would be set free for other purposes.

The Trustees decided to adopt the recommendation, and tenders for the work were invited in February, 1919. The offer put forward by Mather and Platt, Limited, of Manchester, was accepted, they having as sub-contractors for the high-tension electric motors, switchgear and for the automatic high-tension stator and motor the British Thomson-Houston Company, Limited, of Rugby. The specification provided that the plant to be supplied was to consist of two sets of electrically driven turbo-pumps, each set to comprise two separate pumping units mounted on a common bed-plate and direct coupled to the motor fixed between the two pumps, the two pumps of each set to comprise a low-pressure and a high-pressure stage, the two stages being connected by a flanged pipe. Each motor was to be capable of developing 350 brake horse-power when supplied with three-phase alternating 6600-volt 25-cycle current. It was further specified that each set of pumps was to be capable of delivering 400 gallons of water per minute against an accumulator-regulated pressure of 750 lb. per square inch, when running at an asynchronous speed of 1450-1460 revolutions per minute, and that the plant was to be suitable for continuous short period intermittent control service.

The plant as installed conformed in every way to the specified conditions, and, as a matter of fact, the guaranteed overall efficiency at full load was exceeded in the case of both sets. The starting and stopping of the pumps is controlled automatically by the rise and fall of two hydraulic accumulators, and the application of entirely automatic control to extra high-tension alternating-current motors of the size in question, *i.e.*, 350 brake horse-power, engaged in high-pressure hydraulic pumping, was, we believe, without precedent at the time that it was designed, though it has since been copied. It is interesting to note, too, that the automatic control gear which was installed in exact accordance with the engineers' specification required no subsequent alterations whatever. That is a point on which both the consulting engineers and the contractors may congratulate themselves, seeing that the actual combination of apparatus employed had not been used before. It should be recorded, too, that the new plant was substituted for the old without any interruption of the hydraulic services in the docks. A plan of the pump-house as it at present exists is given in Fig. 9, while a photograph of the interior is reproduced in Fig. 10.

In operation, the motors are automatically started and stopped by opening and closing relay switches, which are operated by the rise and fall of the two hydraulic accumulators at predetermined positions.

* No. II. appeared March 6th.

These accumulators are arranged to rise and fall practically together, and both are furnished with tappets. They are housed in a building adjacent to the pump house, and are of very large capacity. Their movements are reproduced in the pump house by means of two electric lights, one red and the other white, which travel up and down in guides fixed to the wall.

These relay tappet switches are of the knife edge type, and they are entirely enclosed in cast iron cases, the operating levers being outside the latter. The switches, which are provided with weights and springs to ensure that they must be either in the "off" or "on" position, open or close the circuit to a solenoid which operates the 6600-volt oil-immersed stator switch, which, in turn, connects, through charging resistances, the high-tension supply mains direct to the motor stator terminals. The closing of the automatic stator switch energises a high-tension transformer, which is arranged in the same casing as the stator switch, and which, in turn, closes a relay switch controlling the rotor contactor switchgear, with the result that the resistances in the rotor circuit are automatically cut out in sequence, the time being governed by rotor current control. The rotor is metallically short-circuited by the closing of the last contactor switch. The rotor contactor switches are of the air-break type, and are arranged to be operated by alternating current at a pressure of 440 volts. The automatic switchgear was designed to deal with a maximum number of starts and stops not exceeding twenty per hour, and the resistances in the rotor resistances for the starting were not to be in circuit for a period exceeding 15 seconds in duration. Views of the switchboards are given in Figs. 11 and 12.

We spent a considerable amount of time, on two occasions, in watching the operation of this most interesting plant. Once, when the load was only varying slightly, and, again, when it was varying quickly between wide limits. We may explain that arrangements can readily be made by which, as desired, either of the pumping units may be the leading unit, that is to say, shall always be in operation as long as there is any demand for hydraulic power. If the demand fall away entirely, then even the leading unit is put out of action till the demand again comes on, the putting out of action being, of course, automatically effected by the tappet-operated switches, which come into play when the accumulators reach the top of their stroke. When there is again demand for power, the accumulators immediately begin to fall, and when they have reached a predetermined point in their downward travel, the leading pumping unit is automatically brought into play. Then, should the demand become greater than the one unit will satisfy, the second unit is automatically put to work. The pumps are started and run up to full speed in an astonishingly short space of time, generally in the neighbourhood of three or four seconds, all the relays, switches and contactors having operated and the inertia of the machines having been overcome in that short time. The operations of both pumps are recorded by means of a Kent flow recorder, which is inserted in the delivery between the pumps and the accumulators. A portion of one of the records of this instrument is reproduced in Fig. 13. When one unit alone is working, only the shorter markings at the top of the diagram are made, the number of times the pump is put into and out of action being indicated by the number of vertical lines. When two units are at work together, the longer lines on the diagram are made, and, because the scale is more open lower down than it is at the top of the paper, the length of the line made by the recorder is more than twice that made when only one unit is at work. It will be realised from the record how rapidly and between what wide limits the demand for

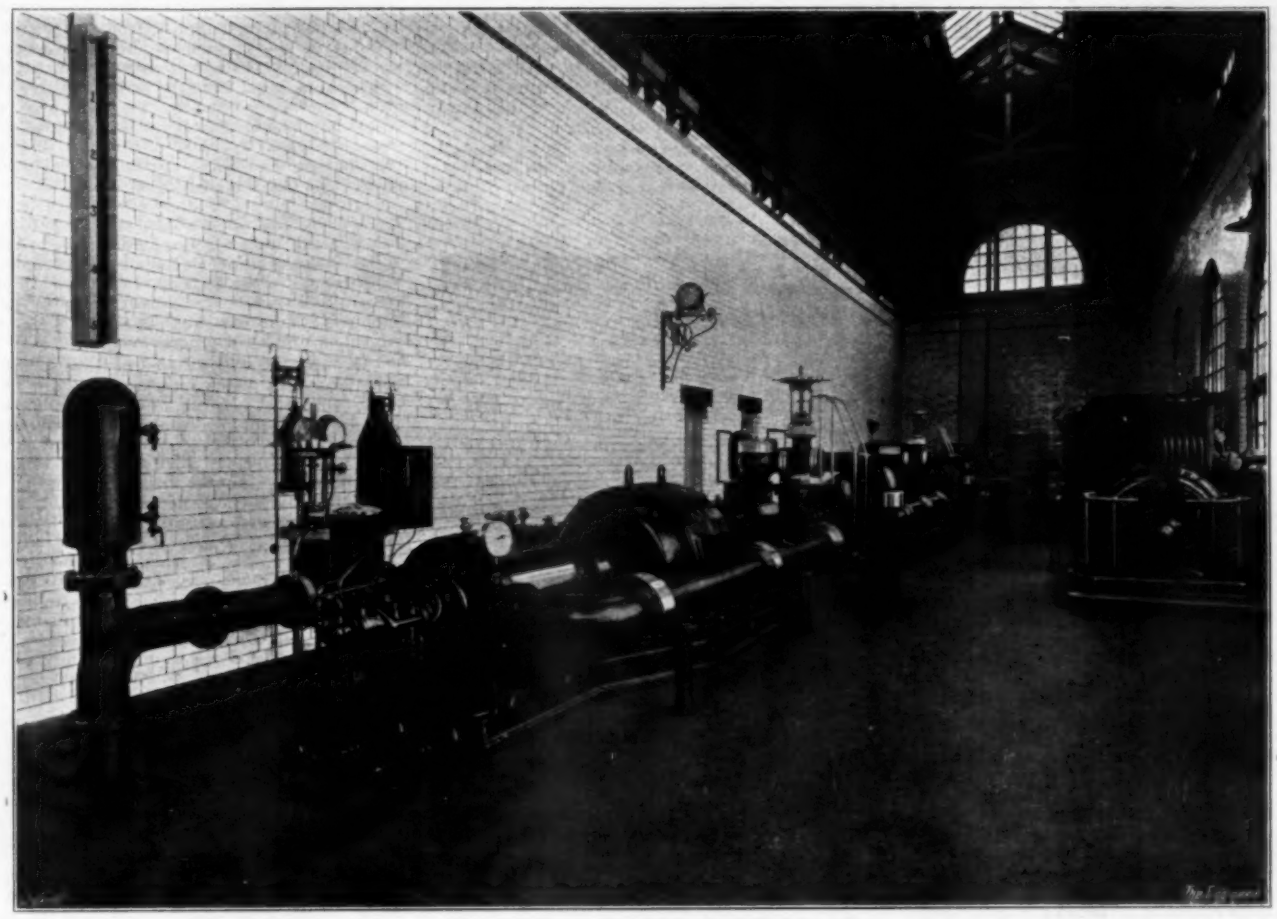


FIG. 10—INTERIOR OF HYDRAULIC PUMPING STATION

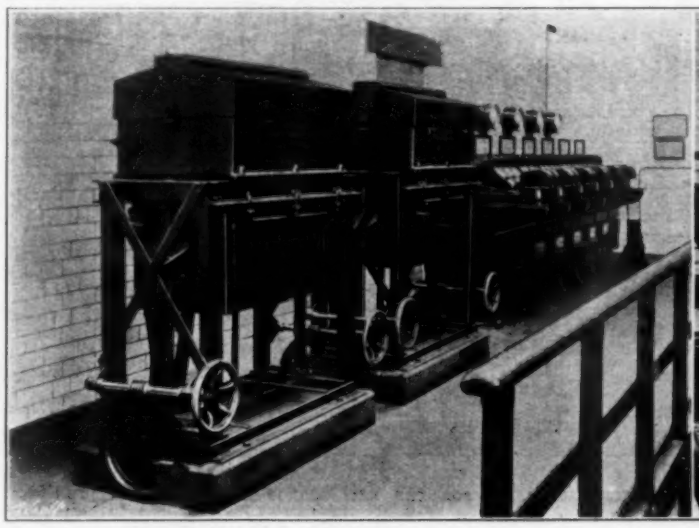


FIG. 11—E.H.T. CONTROL SWITCHES

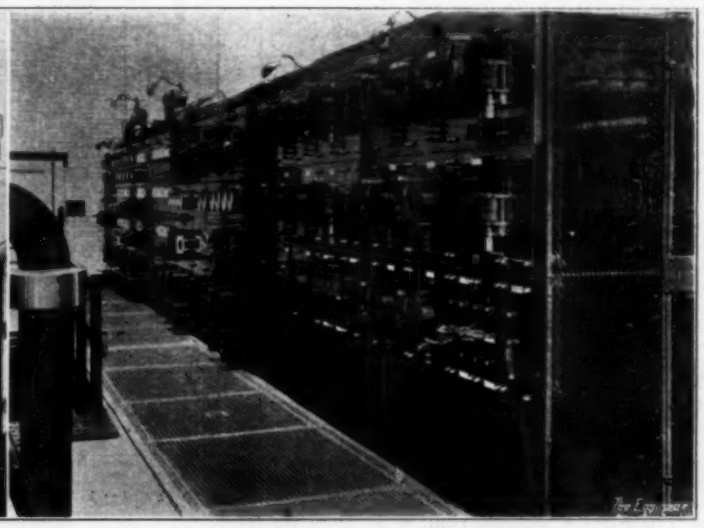


FIG. 12—LOW-TENSION A.C. AND D.C. SWITCHBOARDS

hydraulic power varies. The load, it may be mentioned, comprises a coal hoist, wharf cranes, capstans, &c., and at busy times the automatic arrangements, which are well-nigh uncanny in their almost human operation, are constantly at work, either cutting in or cutting out the pumps.

In addition to the flow recorder instrument, a flow indicator is fitted to the delivery from each pump, and recording water meters are inserted on the suction sides of the pumps to show the quantity of water pumped by each set. These meters, which work in conjunction with Venturi tubes, have also been supplied by George Kent, Limited, of Luton.

The official tests were carried out in April of last year. There was first of all a twenty-four hours' run under normal conditions during which set No. 2 pumped 237,200 gallons, with an average of thirteen starts per hour, and a maximum in any one hour of twenty-three starts, and showed an overall efficiency —W.H.P./E.H.P.—of 57 per cent. The Board of Trade units consumed were 2779.6, and the gallons

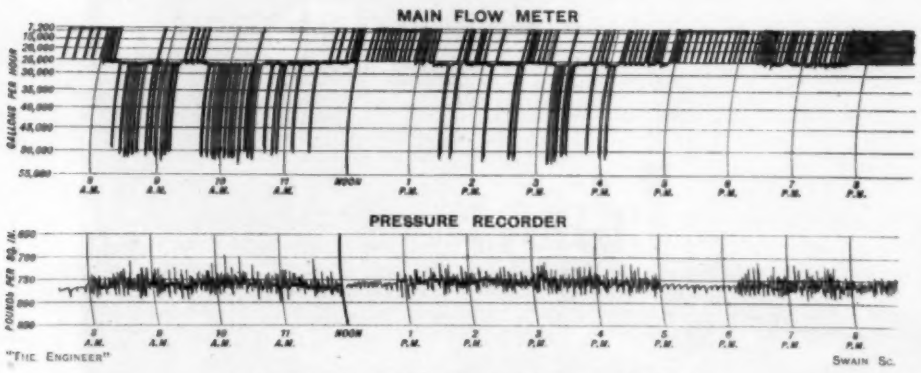


FIG. 13—RECORDS OF HYDRAULIC FLOW AND PRESSURE

pumped per unit 85.3. During the same period set No. 1 pumping 24,542 gallons, used 297.24 units, which represented 82.5 gallons pumped per unit, and showed an overall efficiency of 56 per cent. The average number of starts per hour was eight, and the maximum in any one hour sixteen. It will be observed that No. 2 set did about ten times as much work as set No. 1. At the conclusion of the twenty-four hours' test, both the sets were run for one hour at rather over full load, set No. 2 actually delivering 25,000 gallons and set No. 1 25,929 gallons, full load being 60 × 400, or 24,000 gallons. Set No. 2 consumed 243.8 units and delivered 102.5 gallons per unit, showing an efficiency of 66.45 per cent.; while set No. 1 consumed 272.47 units and pumped 95.5 gallons per unit, showing an efficiency of 63.4 per cent. The guaranteed full-load efficiency was 62.5 per cent., so that set No. 1 was comfortably in excess of the guarantee and set No. 2 considerably in excess.

A noteworthy feature of great interest as brought out by these tests is the high "through-working" efficiency obtained over a period of twenty-four hours in ordinary service with the automatic handling of a fluctuating draw-off by the intermittent starting and stopping of these high-tension electric pumps. Even with the less efficient of the two sets, the overall efficiency with intermittent working was only 6.5 per cent. under the guaranteed figure for full-load continuous pumping. During the test the automatic control of the 6600-volt motors worked smoothly and well, as, in fact, it has since continued to do. The acceleration of the pumping units from rest to full forward delivery into the main is reported to have been very smooth and quick, as, indeed, we found it to be on the occasion of our inspection, and that no doubt accounts for the high overall efficiency obtained under automatic control during the twenty-four hours' working condition tests.

The return water from the various machines which are hydraulically operated is delivered to overhead tanks at the pumping station. This storage of the water at a high elevation results, of course, in the pumps being always primed, but it would, unless something were done to check it, produce back pressure on the rams of the wharf cranes, &c. In order to obviate this defect, the consulting engineers recommended that an electrically driven pump should be inserted in the return main, and its provision has materially accelerated the speed of the machines. The pump was supplied by Worthington-Simpson, Limited. Then, again, for dealing with the somewhat heavy surge pressures which are occasionally met with at the end of the distribution line at No. 1 Graving Dock, which is the furthest point away from the pumping station, it has been decided to transfer an accumulator from another dock to a building adjoining the No. 1 Graving Dock dewatering pumping station. It is proposed to fit this accumulator, which is of very much smaller capacity than the two main accumulators, with "Haarer" control valves, and also with a relief valve to deal with the very quick momentary surges which the inertia of the accumulator would not allow of its responding to; this accumulator was in course of installation at the time of our visit, and we understand that it has since been put to work.

Of the plant as a whole, it would be difficult to speak in too complimentary terms. Its design embodies a departure from previously existing practice, but the facts that the installation has worked well and with a remarkably high efficiency from the very start, and that it has been copied elsewhere, clearly indicate that that departure was justified. If on no other grounds than that the losses inherent in one transformation of the current are saved, the change was warranted, for the loss would probably have amounted to from 6 to 7 per cent., or even more of the current used.

As in the dewatering pumping houses, so in the hydraulic pump house, the plant was, we noticed, kept in excellent condition. It was hard, indeed, to realise that it had been in full operation for some eighteen months. There is one minor detail which struck us as being worthy of mention. It is that the flanges of the high-pressure pipes above the engine-room floor are totally enclosed in casings of steel, which are furnished with only one outlet, that faces downwards towards the floor. The object of these casings is to prevent water being squirted on to the switchgear and other electrical apparatus, should any one of the joints give out. Should there be any discharge of water, it is deflected downwards.

The New London Broadcasting Station.

THE wireless equipment which has been installed in the new London station of the British Broadcasting Company has been designed to conform with the most modern practice. The plant at the old station at Marconi House has never been more than a temporary arrangement, for it was installed at a time when the art of broadcasting was in its infancy. Realising that rapid strides would be made as the result of research work, the engineers of the Marconi Company decided to employ apparatus which could be quickly modified and brought up to date. Gradually the station was altered and made more efficient than it was originally, but its outward appearance suffered in proportion to the magnitude of the changes made. On the formation of the British Broadcasting Company the plant was taken over by that company, although it was still operated by the Marconi Company's engineers. Profiting by the experience gained with this apparatus, the Marconi Company designed its well-known Q type broadcasting station, which is now the standard form of station used in the provinces and also on the Continent of Europe, in South America and South Africa.

The apparatus for the new London station, however, is twice as powerful as that usually employed, and embodies some of the very latest improvements which were introduced for the first time in connection with the broadcasting station at Chelmsford. The new station has two standard Q type transmitters, combined into one, and is rated at 3 kilowatts, but that figure does not, of course, represent the actual amount of power supplied from the mains and employed in the various circuits associated with the transmitter. Three kilowatts represent the power which is radiated from the aerial, but to arrive at the total power absorbed by the apparatus, allowance must be made for the modulator circuits, which have been designed to avoid distortion. The power for the independent drive circuits or master oscillators must also be taken into account when considering the total power used. Power is, of course, consumed by the filaments of the various oscillating, modulating and rectifying valves, and there are the usual losses of power in the motors, generators, transformers and other associated circuits. In all, no less than 18 kilowatts are drawn from the mains, and about 12 kilowatts are supplied to the apparatus during a broadcast programme.

The apparatus is installed in three separate rooms, the largest of which measures 21ft. by 18ft. and is 10ft. 6in. high. In this room the main transmitting apparatus, including the independent drive units, the power oscillator units, the modulation units and their associated high-frequency tuning circuits are installed. Another room, measuring 20ft. 6in. by 14ft., contains all the running machinery, including duplicate motor alternators, which deliver power to the extent of 12 kilowatts to the transmitter, the battery-charging generators, and the switchgear controlling the machinery. The third room, which measures 13ft. 6in. by 15ft., contains the accumulators which supply the current to the filaments of the modulator and other valves, that source of current being chosen in order to prevent any possibility of the characteristic hum of the alternators having any effect on the carrier wave.

Apart from the increased power obtained from this equipment, compared with that of the older equipment, the range of the station will be still further increased by the use of a larger aerial supported at a greater height than that of the aerial at Marconi House, where the building would not permit of the erection of really high towers. The building on which the new aerial has been erected, however, has more solid foundations, and has sufficient strength to permit of the erection of two 125ft. towers, and it is expected that on that score alone the range of the station will be considerably increased, for the height of the towers at Marconi House is only 50ft.

The studio, which has always been entirely distinct from the transmitting apparatus, will remain at the British Broadcasting Company's headquarters at Savoy-hill, and will be connected to the transmitter, as before, by special underground cables.

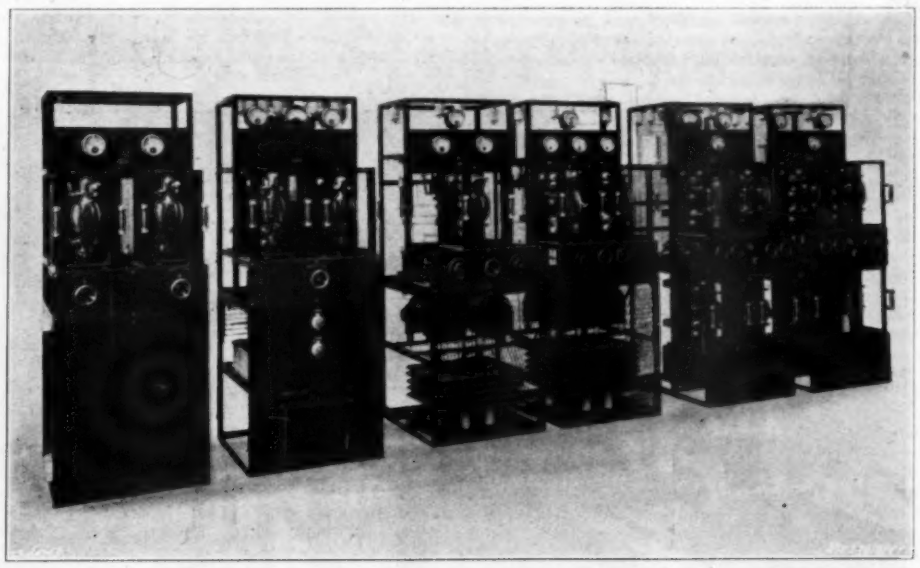


FIG. 1—12 K.W. TRANSMITTING APPARATUS FOR THE NEW LONDON BROADCASTING STATION

The Marconi 12-kilowatt broadcasting transmitter built for the new station is shown in Fig. 1. The first two panels on the left are the rectifying panels, the third panel is the independent drive, the fourth the main oscillator panel, and the two last panels the modulator panels.

For the benefit of those who are unfamiliar with the Marconi Q type transmitter we give in Fig. 2 a simplified diagram of connections, but the transmitter at the new station consists, as we have already said, of

two of these transmitters combined into one. The rectifier, the independent drive, the power oscillator and modulator units each consist of an open steel welded framework in which the transformers, inductances, choking coils, condensers, and other component parts are mounted. The units are erected side by side in the transmitting room and are protected when alive by a system of barriers and interlocking switches, which interrupt the supply when open. Special valves with an open mesh grid are used for the modulating unit, so as to secure distortionless modulation over a wide range of amplitude. Arrangements are also made for impressing a permanent negative potential or "negative bias" on the grids of these valves in order to ensure that all voltage changes take place on the straight part of the characteristic curve and to prevent any grid current from flowing when modulation is taking place. A sensitive galvanometer is included in the grid circuit of the modulating valves in order to indicate to the attendant the presence of grid current so that the controls may be adjusted accordingly.

The function of the rectifier unit is to convert the alternating-current supply at a pressure of 10,000 volts into a uni-directional or continuous current and to smooth out the ripple due to the periodic variations in the electromotive force generated. The rectifying unit comprises two rectifying valves for rectifying the high-tension alternating current from the power transformer, a voltmeter for measuring the high tension direct-current feed current, a step-down transformer for the supply of current to the valve filaments, a voltmeter for indicating the filament voltage, an adjustable iron core choke for regulating the filament voltage, a smoothing system consisting of two iron core inductances and three condensers, an ammeter in the main low-tension power supply and a direct-current feed milliammeter.

The function of the independent drive unit is to control the wave length of the transmitter and to maintain it at a perfectly constant value. The independent drive is one of the main features of the Marconi system of transmission, and it gives great constancy and stability of wave length and freedom from harmonics. The unit consists of a single oscillation valve, a closed oscillatory circuit, including an adjustable inductance, a condenser, a high-frequency ammeter, coils for variable reaction coupling, a variable coupling to the power oscillator grid circuit, and protecting condensers and resistances. The valve filament is supplied with current from a main direct-current battery, and a direct-current voltmeter connected across the filament indicates the voltage.

The power oscillator unit energises the aerial circuit with the full power of the plant at a frequency which is governed by the independent drive unit, and it comprises in the case of the standard apparatus a single oscillation valve, a closed oscillatory circuit, including an adjustable inductance, a condenser and high-frequency ammeter, coils for variable reaction coupling, a variable coupling to the aerial circuit, a feed milliammeter, an aerial tuning inductance, and protecting condensers and resistances. As will be seen from the diagram, the filament is supplied with current from the direct-current mains, and an adjustable resistance controls the voltage across the filament, whilst a direct-current voltmeter across the filament indicates the pressure, which is adjusted when necessary.

The modulator unit to be seen on the extreme right of the diagram magnifies the acoustic currents received from the microphone amplifier and impresses them on the carrier wave by controlling the amplitude of the oscillations generated by the power oscillator.

There are three modulating valves and one sub-modulating valve, protecting condensers and resistances, and a modulation meter. An alternating-current ammeter is connected to a transformer inserted in the feed circuit of the main modulating valves to indicate the degree of modulation. The valve filaments, it will be noted, are connected to the direct-current battery supply in the same way as the filaments of the valves associated with the independent drive and power oscillation panels. The special alternator used with these equipments generates current at a pressure of 500 volts and 300 cycles and feeds the transformer, the motor which drives the alternator naturally being designed to suit the local supply.

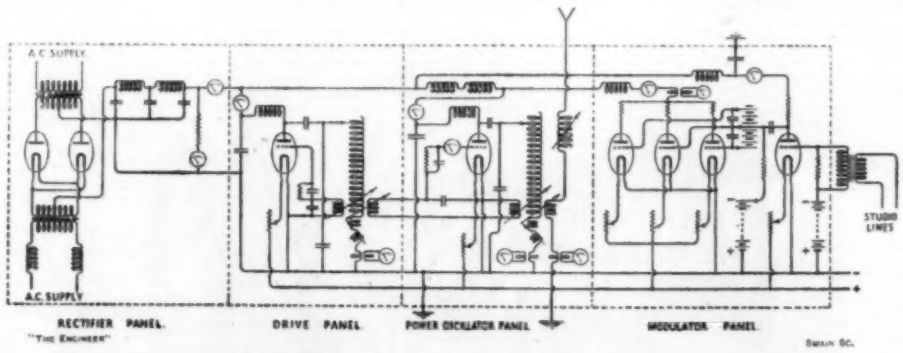


FIG. 2—SIMPLIFIED DIAGRAM OF CONNECTIONS FOR MARCONI STANDARD TRANSMITTER

South African Engineering Notes.

Steel Making in South Africa.

The Union Steel Corporation of South Africa, Limited, held its annual general meeting on February 7th. The profit for the year amounted to £48,998, to which has to be added the balance to the credit of profit and loss account at September 30th, 1923, amounting to £56,688, and there is also added back "funds appropriated for capital expenditure £74,182," making a total of £179,868. Of this amount £157,144 has been transferred to reserve account and £7477 has been appropriated for dividends on preference shares to September 30th, 1924, and £1805 for provision in respect of taxation and bad debts, leaving a net balance to be carried forward of £13,442. The directors' report states that the works have been fully employed throughout the year and the production of finished material has proved a record one. In order to meet competition with other countries it was, however, necessary to bring about a still further reduction in costs for which greater production was essential. Additional capital was therefore necessary to enable the company immediately to extend its sphere of operations and produce on a much larger scale. To ensure the early production of pig iron the Newcastle Iron and Steel, Limited, in which the Corporation already hold a substantial interest, has been absorbed. A cable has been received from London stating that the plant, &c., required in connection with the starting of the Newcastle blast-furnace would be despatched immediately, so that the production of pig iron would be commenced in a few months. To finance the purchase of the Newcastle works and to provide funds for the present immediate extensions to the steel works and also to purchase for £150,000 the large and valuable iron ore deposits on the farm Kromdraai, in the Pretoria district, £300,000 is being raised by an issue of debentures. The £150,000 for Kromdraai is to be satisfied by the issue of £150,000 £1 ordinary shares in the Corporation. The work of building the new 30-ton furnace has now been completed and the new soaking pits are proving a great success, the original heat of the melting furnace being retained right through to the finish of the bar. The foundry plant has been extended by the addition of a Tropenas converter. The production for the year shows an increase of 15 per cent., or a total of over 20,000 tons. The Corporation has sufficient work in hand to carry it well into the year. It has just obtained a big order for castings from the South African Railways. The work that can be handled may be gauged from the fact that the Corporation has at present an order to cast two steel drums for the City Deep gold mine, each casting weighing 18 tons.

Gold Output of the Transvaal.

The total output of the gold mines of the Transvaal for January was 823,692 fine ounces, a decrease on December of 1581 ounces. The value of the gold was £3,498,821, a decrease of £132,380, which is accounted for by the fact that the value of the gold was taken at 85s. per fine ounce, whereas in December it was taken at 88s. Judging from the January output, and taking into consideration the holiday at the beginning of that month, also that owing to a fire destroying its headgear, the output of the Luipoords Vlei, running 4500 ounces monthly, had ceased since October, 1924, though it is likely to restart this month or in April, also that as the result of an accident at the south vertical shaft in December the output of Randfontein Estates was considerably reduced in January, it seems pretty certain that under normal circumstances the output of the Transvaal gold mines will run over 830,000 ounces monthly during 1925. This will mean that not only will the present record of 9,597,634 ounces, made last year, be surpassed, but that the mines will achieve the wonderful feat of producing 10,000,000 ounces in one year. Unless new mines are opened up that quantity of gold will probably mark the climax of South Africa's gold production. It is true that Government Areas is increasing its plant so as to mill 200,000 tons monthly, or an advance of over 35,000 tons monthly on the present production, also that other mines are extending their plants so as to increase their outputs, and that some of these will very shortly be milling on the larger scale; still there is also a debit side. Several mines are nearing the end of their lives; the Wolhuter, for instance, is hardly likely to last beyond 1926, about which time, or perhaps a trifle earlier, the Government Areas will be bringing its big increase into the statistics. Recent discoveries, however, tend to show that there are areas of considerable extent and of good payability yet to be opened. It is possible also that the 2800 or so claims adjoining the Geduld Proprietary mine may be leased by Government to someone before long. So far the Geduld Proprietary has twice tendered for the area, but the Government has declined to lease, although the reason has not been given. The area is still being advertised.

Rolling Stock for South Africa.

In anticipation of a record year for traffic, particularly in maize, the Administration of the railways of the Union of South Africa has recently placed orders for fifteen Class 15A engines to be delivered within the next three to four months, and also for four "G.D." class Garrett engines for the Caledon and Piquetberg branches on Division I. Other orders placed at the same time were for three hundred 50-ton wagons for coal traffic in the Natal Province, seventy-five first and second-class composite main line saloons, and fifty first-class suburban coaches. Thirty-seven of the latter are to be used as plain trailer coaches on the Cape suburban lines to be electrified shortly, whilst the balance has been allocated to the Transvaal, to meet the increased passenger traffic on the Reef, so as to obviate the use of main line saloons, particularly at week-ends and during holiday periods. The new twin-bogie private saloon for the use of H.R.H. the Prince of Wales, and which is now being built at the Pretoria workshops, is well forward as regards construction, and it is hoped that it will be completed by about the middle of April next at the very latest.

Natal's Electric Trains.

The electrification of the Natal main line may not be without its drawbacks. The Colenso electric power station was recently put out of commission for a while, the primary cause being stated to be the very heavy rains which flooded the Tugela River, also the shifting of a sand bank which caused a stoppage in the water supply. The current was thus cut off, stopping the electric trains, which were being used for the conveyance of goods between Ladysmith and Mooi River. Steam locomotives had to be requisitioned to haul these trains, and it is stated that steam locomotives will have to be available at all times in case of emergency.

German Locomotives for South Africa.

The Government of the Union of South Africa, it is stated, is negotiating with the Munich firm of Maffei for the supply of sixteen locomotives for the South African railways. The quotation given is understood to be much below those of British and American firms. Maffeis' have previously executed orders for the Union Government, both before and since the war. Confirmation of this report has not yet been obtained, but it is a fact that the Railway Administration awhile back called for tenders for forty locomotives of different types and the contract that is apparently going to the German firm must be part of that large order. These contractors have been successful before and their engines are understood to have been satisfactory. The engines concerned are probably of the type that cost about £7000 apiece, and the quotation from British firms is said to have been 10 per cent. above the accepted tender.

Progress of South African Railways.

The annual report on the working of the railways, harbours and steamships of the Union of South Africa announces a series of records, and though it only covers the period from April 1st, 1923, to March 31st, 1924, it indicates that progress in the latter half of last year has been rapid.

The total capital expenditure on railways to March 31st, 1924, was £114,769,666; the total earnings for the fiscal year amounted to £21,594,644; the gross working expenditure to £15,980,733; the surplus of earnings over expenditure to £5,613,911; and the net profit, after paying interest, to £1,724,641. The total capital expenditure on harbours was £12,523,771, the total earnings for the year £1,323,798; the gross working expenditure, £614,195; and the net profit, £319,573. The total net profit of the department therefore amounted to a little over £2,000,000. The accumulated railway deficit at March 31st, 1923, amounted to £2,220,510, but after making all necessary deductions and provision for interest, depreciation, &c., there was left a surplus on the last year's working of £1,450,267, and this reduced the accumulated deficit to £770,244. By the end of September last this had been reduced to £151,106, and it was expected that it would be entirely wiped out by the end of the year.

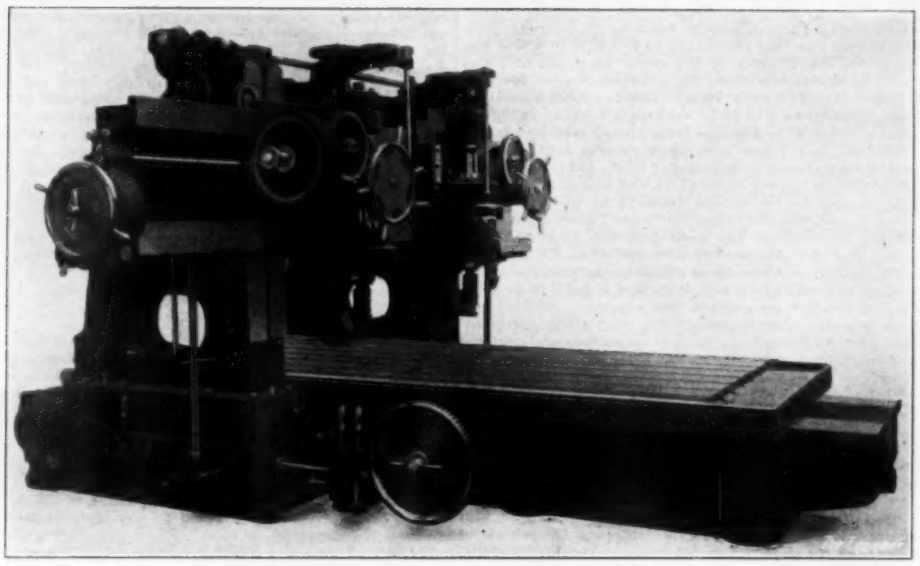
The number of passengers carried by the railways was 65,811,610, and the tonnage of goods 18,838,573. The open mileage was 11,113 miles. The railway revenue was £1,447,847 greater than during the preceding year, or 7.19 per cent.; the gross working expenditure increased by £457,723, or 2.95 per cent.; this was entirely due to the greater volume of traffic. The ratio of working expenditure to earnings was 74 per cent., which is lower than in any recent year. The passenger traffic—65,811,610—increased by 4,229,163, or 6.87 per cent., and constitutes a record. The proportion of first-class passengers was 37.45 per cent.; second-class, 28.81 per cent.; and third-class, 33.76 per cent. The gross tonnage showed an increase of 3,119,709 tons, or 19.85 per cent., and also constitutes a record. The surplus was the largest yet recorded; as also were goods revenue and the tonnage of cargo shipped from Union ports. The train mileage was 38,153,690, another record. Since the close of the financial year—March 31st, 1924—progress has been steadily maintained, and the surplus on working, April–August, was £544,640. It may be noted that in these months the steamships showed a deficit of £7173.

Concrete Cooling Towers.

An interesting contract is now being carried out at the Johannesburg (Transvaal) Power Station in connection with the installation of the new 10,000-kilowatt set. The contract consists of cooling towers of reinforced concrete, each tower being 46ft. diameter and 124ft. high. The walls of the towers are 7in. thick, and are carried at the bottom by nineteen reinforced concrete columns. These columns are supported by reinforced concrete footings circular in shape. The towers are being constructed with the aid of moving forms which are jacked up by means of screws, and which carry the scaffolding and platform for the workmen.

PLANO-MILLING MACHINE FOR PROFILE WORK

WM. MUIR AND CO., LIMITED, MANCHESTER, ENGINEERS



Plano-Milling Machine for Profile Work.

WE illustrate herewith a large two-spindle plano-milling machine, which has recently been built by Wm. Muir and Co., Limited, Manchester, for the London and North-Eastern Railway locomotive works, at Darlington, where its principal use will be for profile milling the edges of long connecting-rods, four at a time or two by each spindle. With this object in view the right-hand spindle slide is provided with a former arm and adjustable conical roller, which is pressed against a former plate by weights suspended on the far side of the machine. The former plates are carried on suitable fixtures on the table alongside the work, and the profiling motion is transmitted to the left-hand spindle by means of a stiff screwed stay fixed on the lower part of the spindle slides. The machine is built to entirely new designs, and is of very massive proportions, the cross slide in particular being unusually deep. To insure the maximum degree of rigidity, the bed is carried down to the foundation and the table and uprights are of extra strong proportions.

The driving and feed change gears are all totally enclosed and run in oil, the changes of speed in both cases being effected by means of hand levers conveniently situated. The machine is driven by two electric motors, one of 20 horse-power for the main drive, and one of 7½ horse-power for the feed and quick power traverses. The control devices for the two motors are embodied in one pillar, and are so interlocked that the feed motor can only be started when the main motor is running, the arrangement also being such that an overload on either motor, or failure of the supply of current, will stop both motors. The cross slide, it should be mentioned, is balanced by means of a large weight accommodated in a pit in the foundation at the rear of the machine. Although the principal purpose for which this machine has been designed is that of dealing with connecting-rods, it is equally useful for dealing with other profiling work, such as is met with in locomotive shops. The following are the leading dimensions of the machine:—Diameter of spindles, 4¼in.; height of work admitted, 3ft.; width of work, 5ft. 6in.; and table traverse, 12ft.

A Motor Coach with Oil Transmission Gear.

THE Swiss Federal Railways are undertaking a good deal of experimental work in connection with the use of motor-driven coaches for branch lines, and the types of

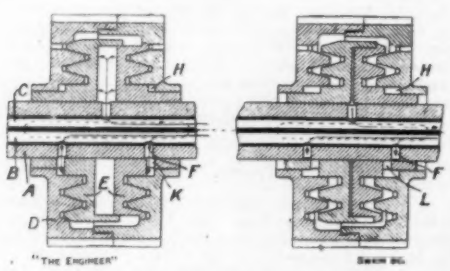


FIG. 1—GEAR FOR MOTOR COACH

vehicle already ordered and in service include a 250 brake horse-power Diesel-electric rail car built by Sulzer Bros. and Brown, Boveri, and two 100 brake horse-power petrol motor coaches. In one of these coaches a Saurer eight-cylinder motor with an ordinary three-speed gear-box is employed, whilst in the other the same driving motor is used, but the transmission gear is of a new type, designed and built by the Swiss Locomotive Works at Winterthur, and described and illustrated in this article. It enables speed changes to be made by the simple movement of a starting handle fixed in the driving cab, similar to the hand lever of an electric controller.

The coach is of the two-axle type and two compartments are provided, with seating accommodation for fifty passengers and a separate compartment for luggage. The coach is entered at the middle and the vestibule gives access to both compartments. Lavatory accommodation is provided, and at either end of the coach a special driver's compartment is screened off. That at the forward end of the coach is larger than that at the rear end, and it also serves as luggage compartment. Hand and Westinghouse air brakes, an air whistle, sanding devices, and a lighting dynamo are fitted. The following are some of the principal dimensions of the coach, the driving motor and transmission gear:—

Overall length of coach	13.73 m.
Wheel base	9.2 m.
Length of body	12.59 m.
Breadth of body	2.86 m.
Height	3.735 m.
Weight unloaded	About 21 tons
Type of motor	8-cyl. Saurer petrol engine
Speed of motor	1000 revs. per min.
Designed output	100 brake horse-power
Speeds	10, 17, 30, and 50 kilometres per hour

The motor and the transmission gear are fixed rigidly to the frame of the coach, the motor being placed at the centre and the speed gear built around the driving axle front. A cardan shaft connects the motor with the change-speed gear, and the motion is then transmitted to the bevel type reversing gear and finally through a pair of spur wheels to the driving wheels. The gears are always in action, and the manner in which they are individually operated is shown by the two drawings reproduced in Fig. 1, which shows one set of gears in the open and closed positions respectively. It will be seen that the gear wheel D is made in two parts, which are secured together and which turns loosely on the bosses of the two internal ring members, E of the friction clutch. Both these internal members turn with the centre shaft A, but are also capable of moving in a horizontal direction. When the coupling is closed—as illustrated in the left-hand view of Fig. 1—oil is admitted under pressure to the central passage C in the shaft A and passes into the space between the ring members, which are furnished with double-coned annular faces, meshing with corresponding grooves in the sides of the gear wheel. Frictional contact having thus been established by oil pressure, the gear wheel rotates with the shaft.

In order to open and to free the coupling the oil in the passage C is allowed to escape and oil under pressure is re-admitted through the passage B to the spaces H, thereby forcing apart the surfaces of the friction clutch. The spaces H are kept continuously charged with oil through the connecting passages F and K. The operating oil is delivered under pressure to the speed change gear by a small rotary pump of the gear type. Referring to Fig. 2, which shows the assembled gear in its aluminium casing, a four-way distributing valve will be seen at the front of the gear-box. This valve, which is operated by link gear connected to a handle in the driving cab, admits oil to any of the four speeds of the transmission gear according to the position in which it is placed.

The driving gear is so arranged that in the "off" position of the control handle all couplings are released. When a speed has to be changed the control handle is brought into the new position and the friction discs of the wheel corresponding to the previous speed are automatically released and the wheel for the new speed put into action. Reversing is accomplished by shifting a pinion placed between two large bevel wheels. For this purpose a special hand lever is provided in each driver's cabin. When the coach has been started the reversing lever is automatically locked, and it can only be thrown into the new position after the coach has been brought to a standstill. When running only two handles have to be manipulated, one for the change-speed gear and the other for the gas mixture regulation. It may be mentioned that the axles of the coach are adjustable to follow curves in the track, and the gear-box is provided with the necessary spring suspension and a universal joint so that it can follow any movement of the driving axle. All the shafts of the transmission gear run in roller bearings and are enclosed in an oil-tight casing. The motor coach described is now undergoing a lengthy trial on the Swiss Railways prior to its being placed in regular daily service. The results obtained so far are, we learn, very satisfactory, and we are informed by Bernard Holland and Co., of 17, Victoria-street, Westminster, the British representatives of the Swiss Locomotive Works, that the same principle has been successfully applied for shunting locomotives and road transport vehicles up to moderate engine powers.

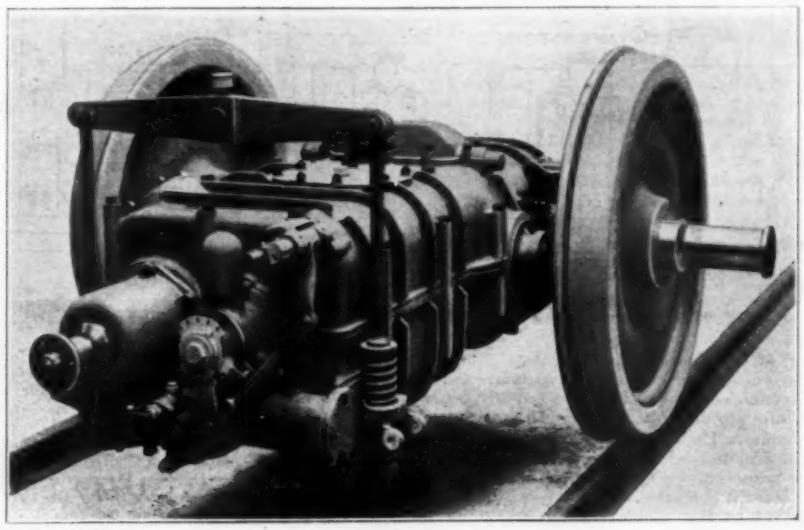


FIG. 2 COMPLETE TRANSMISSION GEAR AND MOTOR AXLE

GERMANY'S MERCANTILE FLEET.

SOME interesting particulars of Germany's mercantile fleet are contained in the *Wirtschaftsdienst*. A review of the financial position of the German shipping industry during 1924 is given, and possible developments are touched upon. To-day the German merchant marine totals 2,953,671 gross registered tons, or about 54 per cent. of the tonnage of 1914, when it totalled 5,459,296 gross registered tons. Had there been no war, the tonnage of the fleet would normally have risen to some 7 or 8 million tons. Of the nearly 3,000,000 tons of to-day, about 700,000 tons consist of older and smaller ships left by the *Entente*, about 500,000 tons chiefly re-purchased from England, and 1,800,000 tons of almost new vessels built between 1920–23. A return of the cost of building modern steam and motor ships gives the following figures:

	Steamers.		Motor ships.	
	9 knots.	10 knots.	9 knots.	10 knots.
	£ per ton.	£ per ton.	£ per ton.	£ per ton.
1000 tons	21	24	27	30
5000 tons	12.5	13.5	19.5	15.5
8000 tons	10.5	11	12.25	12.75

German motor ships form about 6 per cent. of the fleet, as against 18 per cent. in the Swedish and Danish mercantile marines, and 3 per cent. for the whole world, while Germany owns only sixteen ships over 20,000 tons. But with the smaller cargoes available to-day, the smaller vessels have better prospects of making full use of their capacity. During 1924 German shipping did not succeed in securing the majority of the traffic in German ports; 52 per cent. was carried by foreign shipping, and it was

still necessary for a large part of German overseas transports to be effected in foreign bottoms without foreign goods being carried in German ships to a corresponding extent.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

SUTCLIFFE BROS. AND BRYCE, Limited, of Hyde, inform us they have appointed Mr. L. C. Brocks as one of their London representatives.

THE D.P. BATTERY COMPANY, Limited, of Bakewell, Derbyshire, asks us to announce that its telephone numbers are now Bakewell 81 and 82 (2 lines).

WE are asked to announce that Messrs. Ravenshaw and Dyer, consulting engineers, whose present address is Rutland House, Golden Manor, Hanwell, London, W. 7, are removing on March 16th to offices at Carbon Chambers, Hall Gate, Doncaster, which will be their sole address.

MR. J. KIDSTON ALLSOP, M. Inst. C.E., M.I. Mech. E., informs us he has terminated his association with Mr. G. Constantinesco, at 7, Grosvenor-gardens, S.W. 1, and is continuing his practice as a consulting civil and mechanical engineer at Abbey House, 2-8, Victoria-street, London, S.W. 1.

THE Institution of Engineers, Australia, asks us to announce that it has changed the address of its headquarters from the Royal Society's House, 5, Elizabeth-street, Sydney, N.S.W., to Macleay House, 16, College-street, Sydney, N.S.W. (telephone, William 2125; telegraphic address, Enjoaust, Sydney).

CONTRACTS.

THE Glasgow Corporation has decided to divide a contract for water-tube boilers between the Vickers-Spearing Boiler Company, Limited, and Babcock and Willcox, Limited.

THE FARADAY MEDAL.—The Faraday Medal (fourth award) will be presented to Sir J. J. Thomson, M.A., O.M., F.R.S., honorary member, at the ordinary meeting of the Institution of Electrical Engineers to be held on Thursday, March 19th, 1925, at 6 p.m. The presentation will precede the reading of Mr. S. Evershed's paper on "Permanent Magnets in Theory and Practice."

LECTURES ON ELECTRICAL MATTERS.—Under the auspices of the Women's Electrical Association, a course of three lectures will be given at Morley Hall, 26, George-street, Hanover-square, W. 1, at 3 p.m., on the dates given below, followed by discussions, the lecturer being Miss M. Partridge, B.Sc. Wednesday, March 18th, "The Live Wire," the wiring of a house—lamp holders—fuses—plugs, &c.; Wednesday, March 25th, "The All-electric Home"; and Wednesday, April 1st, "What is Electricity?" The lectures are being arranged to suit the needs of every housekeeper, and will be accompanied by demonstrations and slides. Tea will be served during the discussion. Further information may be obtained from Miss Haslett, director, Women's Electrical Association, 26, George-street, Hanover-square, W.

BRINELL HARDNESS NUMBERS.—We have received from the United States Department of Commerce a table of Brinell hardness numbers that has been prepared by the Engineering Mechanics Section of the Bureau of Standards. The table is designed to exhibit the Brinell hardness numbers corresponding to all diameters of indentation ranging from 2 mm. by steps of .01 mm. to 6.99 mm. The standard diameter of ball, 10 mm., is assumed, and the hardness numbers corresponding to the indentations are entered in parallel columns, one of which relates to the standard load of 500 kilos. for soft materials and the other to the standard load of 3000 kilos for hard materials. The hardness numbers are calculated by dividing the applied load by the area of the indented surface, the latter area being calculated by the usual formula from the diameter of the impression. The table is issued by the Department at 5 cents per copy. It may be remarked that some authorities in this country hold that for laboratory work at least, satisfactory Brinell hardness numbers can only be determined by calculating the area of the indentation from the depth of the impression and by taking account of the extra depth represented by the ridge thrown up round the lip of the indentation.

RAILWAY ROLLING STOCK MATERIAL.—The British Engineering Standards Association has now completed the revision of the British standard specifications for non-ferrous locomotive material, Nos. 11 to 15 of B.E.S.A. Publication No. 24. The specifications dealing with copper plates for locomotive fireboxes (specification No. 11) and rolled and extruded copper rods for locomotive stay bolts, rivets, &c. (specifications Nos. 12 and 12A) were issued last year as separate publications, that for extruded rods being a new specification, and these have now been re-issued with those for brass and copper tubes for locomotive boilers and seamless copper pipes for locomotives (specifications 13, 14 and 15 respectively) under one cover as Part 5 (1925) of Report No. 24. The principal modifications made to the brass and copper tube and pipe specifications are the inclusion throughout of tolerances on length, thickness and external diameter, and the insertion of a tensile test and the alteration of the copper and arsenic contents in the copper tube and pipe specifications, the analyses now being made the same throughout all the copper specifications included in Part 5 of Report No. 24. Copies of this volume may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, Westminster, S.W. 1, price 1s. 2d. post free.

A CONSTRUCTIONAL IMPROVEMENT IN SLIDE RULES.—In the ordinary form of slide rule the chief constructional defect is usually found in the means provided to give easy movement, free from play, between the slide and the stock. The movement may be satisfactory at first, but in time the shrinking and warping of the wood, the material from which most slide rules are made, frequently results in the slide sticking and jambing to the great hindrance of rapid and accurate working. In a new form of rule known as the "Glider," invented by John Davis and Son (Derby), Limited, of which we have inspected an example, the trouble indicated has been overcome in a simple but ingenious manner. The slide is split longitudinally to within about a quarter of an inch of each end, and within the split a narrow waved strip of spring steel is inserted. The result is that the slide when withdrawn has a slight bow outwards at the centre, the bowing being just sufficient to provide the small amount of friction between the slide and the stock required for easy operation. The slide, we find, works very sweetly and with almost the same amount of resistance, whether it is full in or almost completely withdrawn. In the sample submitted for our inspection the cursor is not mounted in a square metal frame but is carried on a top and bottom metal strip. It, too, has a noticeably easy motion. The scales on the sample rule are the ordinary A B C and D scales, with sine and tangent scales on the back of the slide. In addition, the face of the stock carries the evenly divided logarithm scale commonly found on the back of the slide, and a sixth scale which, in conjunction with the D scale, enables cubes and cube roots readily to be extracted.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

DULNESS continues to characterise the Midland iron and steel trade, and there are no visible signs of reviving demand. There was a fairly good attendance on 'Change in Birmingham to-day—Thursday—but there is still no disposition to order far beyond immediate requirements. The price tendency generally is on the easy side. Partial employment is general in both the iron and steel trade, and it is dependent on current business to meet urgent needs. Forward buying has been further discouraged by weakening prices. General engineering is feeling no appreciable trade stimulus. There is thus a great deficiency in the consumption of iron and steel at home, and when to this deficiency is joined an intensification of foreign competition, to which our ironmasters are powerless to make effective reply, the deepening depression of the market is not surprising.

Pig Iron Values.

Raw iron prices are so unremunerative, and demand so small, that unless there is an improvement in the near future it is considered certain that further Midland furnaces will be blown out. So few forges in this district are working that there are hardly any serious inquiries for forge pig. Consumptive requirements of the founders are low, owing to the continued stagnation in heavy engineering. The few orders which come on to the market are to satisfy immediate requirements only. Consumers do not see the necessity of operating on any liberal scale, and forward buying is practically non-existent. The market is altogether too narrow to encourage speculative buying, unless producers are prepared to make heavier sacrifices than they would entertain, except under compelling conditions. Smelters who can afford to do so are still offering a strong resistance to the depreciation. The level at which business can be done tends inevitably to fall, however. Northampton foundry iron no longer realises £3 15s., business being easily arranged at £3 12s. 6d, with still lower prices in the rare instances where an attractive tonnage is offered. Derbyshire is also weaker at £3 18s. The furnaces are unable to dispose of their products, and stocks are increasing. Furnace coke is slightly easier, but even with this aid, it is commonly said that the selling price of pig iron does not cover the cost of production. The relief forthcoming in production costs is really inappreciable, for cokeries generally are proportioning their output to contracts, and doing nothing to intensify competition on the open market.

Poor Steel Demand.

There is little alteration in the situation in the steel branches of the market, and producers are getting anxious as to their ability to keep plants going, even to the present extent. Orders are insufficient to give much more than half-time employment, the small tonnages placed causing frequent roll changing, thereby reducing the daily rate of production. Constructional demand shows a slight expansion. Considerable tonnages of work are pending. Engineers are busy tendering for fairly substantial Indian inquiries, and the rolling stock builders have received useful additions to their order books, ensuring activity for some months. Rail orders, however, are trifling in comparison with the large capacity of the mills, a number of which are without employment. The steel trade suffers chiefly from the lack of shipbuilding orders, some of the most important mills for producing rails and plates being entirely unemployed. Fair tonnages of plates for bridges, piers, gas holders, &c., are called for. An unexpected step has been taken by the makers of plates, who were lately appealed to by local engineers to reduce their charges to consumers in this district. Such plates are sold at Middlesbrough at £9 5s., whereas in this district £9 15s. is charged. Instead of reducing the price to Birmingham engineers, the Northern mills have raised their quotation to South Yorkshire to the Birmingham figure. As railway rates are about the same from both districts to the coast, the Birmingham constructors are in a better position to compete with such centres as Sheffield. The official quotations which nominally apply to steel sections diverge widely from the prices which are accepted for anything like bulk orders. Rather more joists are wanted, but Belgian steel is largely used, obtainable at £6 15s. delivered. Many Birmingham merchants are exporting Belgian steel bars to foreign destinations at about £6 5s. Antwerp. Native billets continue at £7 to £7 5s., but rather more Belgian steel is being bought at £6 5s. Increasing quantities of cheap continental steel are being imported for re-rolling, practically in all districts. In spite of the trade depression, lavish expenditure is in progress in the modernising and improvement of steel works plant, steel makers being as confident as ever of ultimate revival.

German Steel Strip.

Germany has appeared in the Midland market as a competitor in bright steel strip, which she is offering in various sizes, ranging from ⅛in. to 9in. This is a useful commodity for a number of Birmingham industries, including that of small tubes, and considerable sales have been made. The foreign article costs about £2 per ton less than the British.

Scrap.

Steel scrap is difficult to sell. The quoted price is £3 12s. 6d., which might be shaded for a good order; but ideas of buyers and sellers differ widely on the price question, and merchants will not entertain the low offers they occasionally receive.

Staffordshire Bar Iron.

In the Staffordshire finished iron department a fair amount of business is passing in marked bars, and the basis of £15 is unchanged. The other departments complain of inactivity, and the current quotations are often shaded. Crown quality iron is quoted at £12 15s., but transactions have taken place at several shillings below that figure. Nut and bolt makers declare that business is not likely to make much progress until more contracts are given out in connection with railway extensions and shipbuilding. The operations of the latter continue to be very restricted. Nut and bolt iron at £11 15s. is largely unattractive as against Belgian material, obtainable at £4 per ton less. In spite of the defects of the latter and its recognised steely quality, nut and bolt makers cannot ignore this large difference in the price. The Staffordshire ironworks continue poorly employed, but are taking advantage, in competition with steel works, of the re-rolling of steel bars, largely by the use of foreign material. The persistent slump in the shipyards reacts on a number of the South Staffordshire industries.

Galvanised Sheets.

Galvanised sheets have receded farther, being obtainable at £16 10s., though all mills are not prepared to submit to this level. Indeed, a few continue to quote £16 15s. for 24 gauge corrugateds. The home demand shows no improvement, but the export consumption continues fairly good. The tin-plate trade shows a slight improvement. Thinner gauge sheets and black sheets are in moderately good request.

Iron Trade and the Bank Rate.

Trade is so depressed in the Midland iron and steel and heavy engineering industries that the change in the Bank rate has excited little interest. It is recognised that, with industry so deeply engaged to the banks as it now is, an advance approaching 25 per cent. on overdrafts must have far-reaching effects, and ironmasters let it go at that.

Edge Tools.

The Midland edge tool industry shows a better tone on the export side, quite a fair amount of business being done, and merchants are inclined to take the view that prices are now stabilised. Foreign competition remains a very serious factor, particularly from Germany and the United States. The Argentine demand is fairly good, and Mexico is expected to develop into quite a satisfactory market. Brazil, usually a very good consumer for edge tools, is at the moment calling for only poor supplies. South America, on the whole, is fairly good, and South Africa and India are improving, but generally prices are very keen.

Unemployment.

A further decrease in the number of unemployed in the Midlands is recorded this week, the total being 135,977, as compared with 137,762 the previous week. The present total is made up of 95,472 men, 1695 boys, 35,698 women, and 3112 girls. To the total, the Birmingham area contributes 27,780; Coventry, 1372; Bilston, 2918; Cradley Heath, 4972; Derby, 1854; Dudley, 3853; Leamington and Warwick, 533; Leicester, 3603; Northampton, 1473; Nottingham, 8071; Oldbury, 1601; Peterborough, 502; Redditch, 1156; Smethwick, 4574; Stoke-on-Trent area, 12,957; Stourbridge and Brierley Hill, 3983; Tipton, 2232; Walsall, 5491; West Bromwich, 2961; Wolverhampton, 5408; Worcester, 2063; and Wednesbury, 2943.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Iron, Steel and Metals.

THE general condition of the iron, steel and metal markets here has not by any means improved during the last week. Even in talking to the more optimistic members of the Manchester Exchange one gets the impression that all expectation of any immediate improvement has been abandoned by them. The disappointment is no doubt very great because some far-reaching hopes were built upon the trade prospects of this year, more especially after a stable Government had been established. Manchester opinion was very much disturbed by the lightning strike at one of the leading engineering works; and there was considerable anxiety felt as to the condition of the dispute between employers and employed in the engineering trade; but, of course, these are more or less temporary matters, and the causes of stagnation in trade are much deeper.

Metals.

The very hopeful feeling which prevailed earlier in the year in the copper market seems to have disappeared, so far as Manchester is concerned. Merchants take a rather pessimistic view as to the immediate future, although it is generally admitted that prices cannot recede very much. The expectation of a steady advance is, however, put off for the present, and there is little life in the market here. There has been a small reduction in the price of strong sheets, and it is expected that something will be taken off the official tube prices; but all these manufactured prices are very unsatisfactory to the engineering trade. It is, for instance, very galling to the struggling engineer to be charged £95 per ton for strong sheet copper when he knows that similar material is being sold to the Indian market at £83 per ton. Reports from America indicate that the demand for copper is fairly good there, and at the moment the weakness seems to be in Europe rather than in America. The demand in the Manchester market for scrap copper and brass is again very much restricted, and dealers complain that there is scarcely any outlet for their stocks in spite of the comparatively low prices quoted. For old gun-metal the market is perhaps weaker than for any other scrap, and dealers are reducing their buying prices to £46 or £47 per ton. The

market for tin is again in a very uncertain condition. There was only a slight recovery after the slump of last week, and then a further slight break took place. There is nothing in the statistical position to account for the fall in prices; but the fact is that tin prices have been under the influence of sentiment for a long time, and this being the case it is impossible to find concrete reasons for the market movements. The market for lead has been rather inclined to ease, and there is no doubt that consumers are by no means satisfied with the position, and are buying only sparingly. Meantime the rate of consumption throughout the world is very large. If the reported agreement at the Broken Hill mines means that peace is secured there for three years, it may be that the output of lead will be increased to a considerable extent. The position in the spelter market does not show very much change. Prices are about as they were, but the demand from the galvanising trade is said to be a little better.

Pig Iron.

The markets here for pig iron of all kinds remain in a very dull condition. There is some business, of course, but it is mainly of a retail description. A good many of the ironfounders of the district have No. 3 Derbyshire iron to receive against old contracts at 90s. per ton delivered, and as they could now buy the same iron at much less, they are in a difficult position, if they have worked out all the old orders for castings. There is the keenest possible competition for new orders, and any disadvantage in the way of dear iron is awkward. The whole history of the market recently suggests that those are best off who get their orders for castings before they make any contracts for pig iron, and this leads to a retail system of buying. It is difficult to say what would be the lowest price accepted this week for Derbyshire No. 3, but there are reports down to 78s. at the furnaces, or, say, 85s. 6d. per ton delivered here. The leading sellers, however, do not quote below 86s. 6d., and there are one or two brands held for 87s. 6d. It may perhaps be said that 86s. is about the selling value in Manchester. At this price, or a little less, Northamptonshire iron can be bought here, but one does not hear of any business in it. As, however, Northamptonshire at the furnaces is about 4s. to 5s. per ton below the Derbyshire price, it is clear that the position is not sound, and consumers are encouraged to believe that the fall is not yet over. The demand here for Scotch iron is very small, but there is not much alteration in the position. Hematite from the East Coast is, of course, easy on the extreme dullness in the steel trade.

Finished Materials.

Sellers in the manufactured steel market report a very restricted trade, but for the most part they do not admit that the prices are any lower. As a rule, £8 15s. delivered in this district is quoted for joists and angles, and £9 15s. for plates; but the latter can certainly be done for less. Round bar-steel varies a good deal, but on the whole it is easier. Flat bar-steel is dull at about £9 10s. per ton. The condition of the finished iron trade is no better, and the very wide difference between Lancashire prices and those asked for the better kinds of foreign iron is so great that users are tempted to take the risk of inferior quality. If we could have Lancashire iron at £1 or even £2 per ton above the price of foreign, it might be possible to keep the latter out to a large extent.

Scrap.

Dealers in the market for old iron and steel are very pessimistic just now They complain that if the prices go much lower it will be impossible for the trade to bear its own expenses unless labour becomes cheaper. To break up old machinery is already becoming unprofitable; and the present railway rates are a heavy burden, to say nothing of cartage, loading, &c. In Lancashire dealers still offer 62s. 6d. for heavy steel melting scrap, but they are not keen buyers. The usual price for small lots of ordinary cast scrap is 80s. delivered; but for special qualities 85s. to 87s. 6d. per ton is asked. Heavy wrought scrap is not in very good demand, but 85s. would be paid for good parcels delivered at the forges.

The Engineers' Club.

The annual report of the Engineers' Club, which has just been published, must be considered highly satisfactory from every point of view. In spite of the depression in nearly all branches of the industry, the report states that the number of members remains practically the same as in the previous year, namely, 779. Financially the club appears to be in a very sound position, a loss of under one pound during the year on a turnover of over £11,000 being more than compensated for by an amount of £300 set aside during the year for the purchase of shares in the club company from the relatives of deceased members. As a place of meeting for the engineering societies the club is proving highly popular, and the inconvenience to the members which was formerly brought about by these meetings has now been remedied by the recent extensions of the club premises. It is pleasant to note that a Trust Fund has been founded by the club, with the object of training and educating the sons of deceased members, either as engineers or architects. This fund now amounts to over £800, which is invested in the names of trustees, and the interest will be applied to the purpose mentioned. The annual meeting of the members is to be held on March 24th.

Barrow-in-Furness.

Hematite.

The hematite pig iron trade is, if anything, a little easier. One of the signs, a fall in price, is evidence of this fact. All business done is for the supply of immediate requirements, and there is no inclination to place orders for forward delivery. Neither Scotland nor the Midlands are taking a large quantity at present. As to prospects it is difficult to speak. Some say that the Budget may have some effect on business, whilst others are of the opinion that the demand does not exist.

Iron Ore.

The iron ore trade is just moderate and no mine is experiencing brisk business. There are only thirteen furnaces in blast in the district, excluding the charcoal furnace at Backbarrow and the demand from outside is small. Neither local nor outside prospects are bright at present. The amount of foreign ore coming in is to a certain extent restricted.

Steel.

There is no improvement in the steel trade. The Workington rail mills have not got orders to keep them going regularly, and the same remark applies to the Barrow rail mills, which have temporarily stopped for a week or so. The hoop and small section mills are better situated.

Shipbuilding and Engineering.

Information received from Australia indicates the possibility that Vickers Limited may get the order for the two cruisers. One of them would be built at Barrow and the other at Cockatoo Island, under the control of Vickers. It is known that Vickers Limited put in a very keen tender for this work, and that the placing of the contract is about due. This order would be a help to the Barrow yard, where the berths are getting thin. Only two ships are now on the stocks, the Orient liner Otranto and the British cruiser Cumberland.

SHEFFIELD.

(From our own Correspondent.)

The Basic Steel Depression.

The situation in the raw material and basic steel trades of Sheffield is causing great anxiety, for a state of depression has now lasted a considerable time, and it appears to get worse rather than better. Owing to the absence of forward buying of pig iron, prices have eased. Very few substantial contracts for basic billets have been booked for several months, and matters have reached such a condition in the Rotherham district that four large furnaces have been put out of commission, which means a reduced production to the extent of nearly 2000 tons per week. The makers were faced with the choice of either damping down or making for stock or bringing down prices to a point below the cost of production, and they selected the lesser evil. The scrap market is suffering in sympathy with those for the other raw materials of the steel trade.

Railway and Engineering Work.

On the acid side of the steel trade conditions are much better, and there has been an increase in production lately, although the total is still below the normal. A large tonnage of this material is called for by the orders for railway supplies which are on hand, and by heavy engineering requirements. Only a moderate amount of work is on hand in the armament departments. I have already mentioned that Vickers Limited have submitted tenders for the two Australian cruisers, and now the report comes from Sydney that it is expected that that firm will build the vessels, one being constructed in England and the other in Australia. A confirmation of this report will be eagerly welcomed in Sheffield, as the orders would be a valuable help to the heavy forging and armament departments.

The Tool Trades.

Some firms engaged in the manufacture of hand and engineers' small tools continue to book a good weight of orders, and there is not much short time in these branches, but, nevertheless, things are reported to have quietened down somewhat recently. The makers of farm tools are the best employed of all. For some time there has not been much activity in sheep shears, but a little improvement is now noticed. A cheering feature of the situation is an increased demand from South America for Sheffield tools. Fewer German products are now going to that important market, and the prospects for the local trade are considered good. A large business is being done in builders' and contractors' tools, and further orders are looked for. Much inequality prevails in the file trade, where, although several of the large houses are well employed, the rest are not well off for work. In the hacksaw trade lately there has been a falling off of orders, and complaints are heard of severe price competition among the makers. In small carbon steel twist drills, a good deal of German competition is being felt. Owing to new exchange difficulties in France and Italy, the buying of special tool steels by those countries has further declined, and the trade in tungsten, ferro-chrome and other ingredients of high-speed steel is on an unprecedentedly small scale.

Smoke and Steel Production.

Periodically an outcry is raised against the production of smoke by the Sheffield trades, but it is generally recognised that Sheffield is in an exceptional position, and that any drastic order for smoke abatement might have a very damaging effect on the trade. The Master Cutler, Mr. W. W. Wood, in a speech a few days ago, put the matter very plainly. He said the Sheffield manufacturers did not delight in smoke, nor did they adopt a *non possumus* attitude in the matter; on the contrary, they had spent, and lost, a lot of money in their efforts to eliminate smoke in the processes in which their experience had taught them that it was necessary. If he were told that he must not make any more smoke, then he must not roll any more high-carbon rod, any more high-carbon sheet, any more thin sheets, &c. They all knew what fatal results there would be to certain works on which Sheffield had built its name if they had no smoke at the initial stages. It was not possible to supply certain steel without the material being heated in smoky flames. Sheffield manufacturers were just as anxious as anybody else to eliminate the smoke nuisance, and it was a matter that was constantly before them; but they knew their trade better than any outsider knew it, and they were not going to disclose the secrets of their trade for the benefit of certain people outside the city.

Future of the Steel Trade.

The Master Cutler also made some interesting remarks with regard to the future of the Sheffield steel trade. The reputation of Sheffield, he said, had been built up not so much on bulk products as on high-grade material and quality of workmanship, and it was of the utmost importance that both the latter should be maintained. There had been many changes in recent years, but the position to-day was that in bulk steel, at any rate, Sheffield could not compete with the foreigner. It was, however, no good sitting down and bemoaning their fate, or expecting some superman to arise and miraculously put everything right. He was addressing the members of the Sheffield Trades Technical Societies, and he expressed the opinion that improvement, when it did come, would be a result of the individual efforts of the people of the country and the application of the experience and the co-operation of such as he saw before him that evening. The scope for research in the Sheffield trades was practically unlimited.

Stain-resisting Silver.

Only two days before the Master Cutler made this speech, a remarkable instance of the success of research work had been made public at a meeting of the Silver Trades Technical Society. Having produced an article of revolutionary value in stainless steel, Sheffield has for some time been trying to evolve a material of corresponding importance to the silver trade. Now a tarnish-resisting silver has been produced, and has given remarkable results. It is not the first of its kind, for a similar material was introduced a year or two ago, but, although the claims of that material to tarnish resistance and absence of "fire mark" have been found to hold good, twelve months' experience have shown that it has certain disadvantages in colour and presents difficulties in practical work on account of low melting point and consequent sagging in soldering operations. Research has been carried out by a committee of the Silver Trades Technical Society, in co-operation with the local section of the Institute of Metals. The new material has been produced by Wm. Turner and Co. The new material has many advantages, according to the report of the investigation committee. It has not only come through severe tarnishing tests with remarkable success, but its working properties are found to be equal to those of sterling silver. It stands every legitimate soldering test, is extremely ductile, and will spin easily, and can be stamped without difficulty. Troubles with regard to buffing and finishing, colour and casting have still to be overcome, but the experts are hopeful of success in these directions. The committee expresses the opinion that the silver trade will benefit considerably as a result of the important research which has been carried out. As my notes have shown on many occasions, the trade in sterling silver has for a long time been of unsatisfactory proportions, and the President of the Silver Trades Technical Society is of opinion that the downward movement can only be overcome by the production of a silver which will not tarnish so readily as sterling.

Cutlery and Plate.

Disappointment is felt in the cutlery and plate trades at the fact that the promise of the early part of the year has not been fulfilled. Travellers report that the demand from the retailers is very unsatisfactory. Although stainless steel knives are still being produced in large quantities, the output is not up to last year's level. Competition continues extremely keen, and the figures quoted by different makers show wide disparities. Although German competition in pen and pocket knives, scissors, and razors has fallen off, the local trade in these branches has not benefited much up to the present, as there are still considerable quantities of imported goods in the country. There is much activity in the spoon and fork departments, but comparatively little is being done in silver and plated hollow-ware.

Colliery Progress.

The latest news with regard to colliery developments on a large scale comes from Sutton, a few miles from Bawtry, in the Doncaster area, where it is understood that boring operations are to be put in hand at an early date. James Nimmo and Co., Limited, the well-known colliery proprietors of Glasgow, have obtained a lease of a considerable area of coal, which is contiguous to the royalties held by the Harworth Main Colliery Company. At Thorne, progress in sinking is reported. No. 2 shaft has reached a depth of nearly 700 yards, and it is expected that the Barnsley seam will be struck about midsummer. The depth at which that seam was found in No. 1 shaft, in August last, is 921½ yards. The Railway and Canal Commissioners have given the New Hucknall Colliery Company, Limited, permission to work a pillar of coal under Kirkby-in-Ashfield church. Another matter which will come before the Commission shortly is an application by Earl Fitzwilliam for permission to work about 25 acres of minerals, in small parcels, lying underneath the Parkgate seam at Greasborough. The applicant is already working 4000 acres of coal surrounding these parcels.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

Unsatisfactory accounts continue to be given of all branches of industry in the North of England, and at the moment there is little on the horizon to give much hope of improvement in the near future. Mr. J. J. Burton, a well-known ironmaster, who has had a long connection with the Cleveland iron trade, declared this week that the depression had never before been so deep as it was at the present time. We were passing, he said, through one of those periods when, generally speaking, the rewards of industry were absent, and the products of labour were at a minimum. The present difficulties confronting trade and commerce seemed almost insuperable, and were undoubtedly serious, but he believed they could be overcome

if they unitedly tried to meet them. The situation is certainly discouraging. Business on all hands is the merest minimum, and most industrial plants are poorly engaged.

Cleveland Iron Trade.

A cloud of depression still overhangs the Cleveland pig iron trade. There appears to have been a little more business done during the last few days, and buyers have held off the market so long, that there seems reasonable grounds for the belief that were prices to stiffen there would be an immediate rush of orders. But, as yet, prices have been inclined to sag, and buyers consequently are waiting until they see evidence that the market has touched bottom. Makers assert that this point has already been reached, and where consumers have shared that view they have placed orders. The business booked has been chiefly with Scottish works, but a few small export orders have also been placed, and if the rising tendency of prices on the Continent continues the position in that direction may alter in favour of Cleveland makers. Meanwhile, however, they find it difficult to dispose of the whole of their output, and whilst quoting 78s. per ton for No. 3 Cleveland pig iron are prepared to shade that price where the attraction is sufficiently great. No. 1 foundry iron is 83s., No. 4 foundry 77s., and No. 4 forge 76s. per ton.

Hematite Pig Iron.

The East Coast hematite pig iron trade shows absolutely no improvement whatever. Production is restricted, but there is still very keen competition for a limited volume of orders, and 85s. per ton is a full price for mixed numbers, and 85s. 6d. for No. 1.

Ironmaking Materials.

The foreign ore trade is lifeless, but nothing less than 22s. per ton is named for best Rubio ore c.i.f. Tees. Durham blast-furnace coke is weaker at 23s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trade is unchanged. The demand for semi-finished material is only very moderate, consumers having apparently satisfied their requirements, as they are not tempted by the cheap rates at which imported products are offered. Sales of finished steel are difficult to arrange, and buyers are disinclined to negotiate for forward supplies to any extent. With the exception of a 10s. drop in galvanised sheets this week, quotations are unaltered.

The Coal Trade.

There is not the slightest improvement in the Northern coal trade, and with so few inquiries coming on the market, and the severe pressure and competition of continental coals, the prospects ahead are still very disappointing to owners and exporters. The open winter in the Baltic has not exhausted supplies, and with cheap German coals on offer, inquiries for British coals are of a tentative character, and apparently put forward simply with a view to testing prices, as compared with competing coals. The French State Railways—usually good customers in this area—are stated to have decided to use French coal only during the present quarter; and with Belgium, Holland, and the North Sea ports of Germany all over-stocked, shippers have prospects of a quiet time for some weeks. Although production of many qualities is being steadily curtailed, the outputs are still abundant to meet all requirements, and quotations generally show little change, and if there is any alteration, it is still tending downwards. Many more pits in Northumberland and a few in Durham are closing down, and in Northumberland 8000 men are idle, and 23,000 in Durham, and during the next week or so these numbers will be increased, for over 3000 men in the former county are under notice. The coke trade is very quiet. Gas coke shows little movement, and with stocks abundant, prices are weakening.

SCOTLAND.

(From our own Correspondent.)

Continued Stagnation.

THERE is at present nothing apparent calculated to indicate a brightening of the industrial horizon, and business on all sides can only be described as deadly dull. Consumers everywhere are buying only the merest necessities for immediate use, and there is not the slightest inclination to transact forward business, even on the most limited basis. Less has been heard lately of foreign competition, but this is probably due to a general lack of orders rather than to any slackening of foreign efforts to capture trade.

Pig Iron.

The turnover in the pig iron market is very feeble, and makers cannot find an outlet for their most limited production. Stocks in makers' yards therefore continue to increase. Dealings in hematite and foundry iron are absolutely on a hand-to-mouth basis, and almost entirely for home consumption, the export department being practically dead meantime. While prices are nominally unchanged from last week, buyers with fair orders to place could easily gain further concessions.

Steel.

Specifications for steel plates and sections are disappointingly few, even allowing for the comparatively quiet conditions ruling at the shipbuilding yards and engineering shops. Any business coming on the market is keenly competed for, but home producers are at a distinct disadvantage in the matter of price. Sectional steel is in pretty much the same position. Sheets continue to do well in export directions, so far as light sheets are concerned, but the home demand has tapered off. Galvanised sheets are particularly well off for orders, and are very firm in price. The demand for scrap is very irregular, and cheap terms are obtainable.

Bar Iron.

Reports from the bar iron works are merely a continuance of the tale of lack of specifications. Makers have great difficulty in securing sufficient business to maintain even a minimum amount of employment from week to week, the market being very dull and lifeless. The basis price of bar iron is nominally unchanged. The re-rolled steel branch of this industry improves a little, with prices remaining between £8 10s. to £9 per ton, home or export.

Coal.

The recent unsatisfactory state of affairs in the Scottish coal trade has become even more pronounced during the past two weeks. The diminution in the foreign trade has caused acute depression in the coal industry, and already at a number of pits a stoppage has taken place. Notices have now been posted at several more pits, and this movement is likely to continue until there is some indication of improvement. High costs of production and weakening prices, coupled with the loss of overseas business, are responsible for the present position. Hardly ever in the history of the trade has foreign business of a prompt nature been so scarce, while forward transactions have hardly been mentioned for some time now. Exporters have done their utmost to combat foreign prices, but even where they are prepared to discount local values the results of their efforts have been most exasperating. For some time past Lanarkshire splints have maintained a fair degree of firmness, but a weaker note has at last been struck, and this fuel is likely to fall into line with other descriptions of round coal. Washed treble and double nuts are especially weak, as these are being pressed for sale. Aggregate shipments amounted to 220,502 tons, against 231,475 tons in the preceding week and 269,345 tons in the same week last year. So far as the home market is concerned, supplies are more than sufficient to meet all demands, and only in the case of best household fuel is there the slightest difficulty in securing prompt deliveries.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE position in the steam coal trade is viewed with increasing anxiety in view of the extreme paucity of orders and the unremunerativeness of what business is available. Shipments have fallen off materially of late, and compare very unfavourably with the returns of a few weeks ago, while set beside the figures of a year or so ago, they make very unpleasant reading. With orders so scarce, it follows that there is not the demand for tonnage, and the supplies in dock are below what are required to lift the coals that are available. Few colliery undertakings can keep their pits working anything like regularly, because the standing coals are so heavy that empty wagons are not at their disposal. Although there was a fair number of tonnage arrivals over last week-end, the returns showed that at the various docks quite a dozen loading appliances were idle, which is a very poor start for the week. In the circumstances, the market for prompt loading continues to be easy, and for the few orders that collieries can secure, they are compelled to make sacrifices and accept prices which are below production costs. Apart from the fact that foreign consumption of coals is below the normal, which has resulted in a diminished inquiry, there is no doubt that the adverse condition of the foreign exchanges is operating against many buyers abroad coming to this country for their requirements.

Lost Orders.

It is an undeniable fact that many firms in this district which formerly had valuable connections and used to be regularly engaged in shipping coals from South Wales to near continental ports, have during the past few months come practically to a standstill. Their business has shrunk to a shadow of what it has been in the past, and unfortunately there seems to be very little hope of any immediate improvement, owing to the high price of coals, compared with those of continental qualities. Foreign competition is extremely severe, and discussions in coal trade circles of late have been more concerned with orders that have been lost than with orders that are obtainable. Some of the shippers of coal to France received a shock last week when the news came through that the French State Railways were not coming to this district for supplies. These railways recently asked for tenders for 20,000 tons of small coals and 10,000 tons of large for delivery over the next three months. The c.i.f. prices quoted by local firms averaged 17s. 11d. per ton for the smalls and 26s. for the large, which prices left an approximate price of 13s. 11d. f.o.b. for the smalls and 22s. for the large, but the railways decided to place orders with French collieries for 100,000 tons of small coals and 40,000 tons of large, and from all accounts there is the probability that the railways will not take any coal from South Wales during the remainder of this year. Certainly it is not expected that they will come to this market before October next. Hopes are entertained that this will not be the case, as it will be a very serious loss to this district. The report has also come to hand that the Paris–Orleans Railway has decided not to purchase coals from South Wales during the next three months, and it is understood that the reason for this is the long delays experienced in loading tonnage at Welsh ports, as compared with other districts, and especially on the Continent. It is pointed out that whereas steamers sent to South Wales docks load only about 700 tons per day on an average, vessels taking in coal at Hamburg, for instance, average 2000 tons per day. This, of course, means a big saving in time and expense, and it has to be remembered that the Paris–Orleans Railway is also a shipowner under the name of the Société Maritime Auxiliare de Transport, controlling about twenty-five steamers, so that for it the question of quick loading is of primary importance. Shippers to South America have also been cut out by Germans and Americans, the order running to about 12,000 tons. This business had previously almost invariably come to this district, but on this occasion it was lost, and it is stated that the price quoted by the Germans was shillings below the South Wales prices.

Anthracite Colliery Deal.

The report is current that negotiations are in progress involving the transfer of anthracite colliery property in this district, the undertaking concerned being the Brynhenllys Colliery, near Cwmllynfell, in the Swansea Valley, while the buyers are said to be T. H. Henderson and Co., Limited, of Swansea. About 300 men are employed at the Brynhellys Colliery, which has a daily output of about 200 tons.

Steel Competition.

In the course of an address delivered recently at Swansea, Mr. Lewis Jones, the secretary of the South Wales Siemens Association, stated that whilst the present world capacity for producing steel had increased by 44 per cent. over the production of 1913, the capacity of European production had only increased by 25 per cent. The exportable surplus of steel products in Europe and America was a very serious menace to this country. Referring to the local area with Pontardulais, Llanelly and Port Talbot as the points of a triangle, he said that in it fifteen steel works produced in 1924 1¼ million ingots, which was 18 per cent. of the output of Great Britain. Within the triangle there were about seventy tin-plate and sheet works, and he doubted whether in any part of the world there was such a small area responsible for such production of iron and steel. Dealing with the present depression in trade, Mr. Jones said that it was the more serious that the whole of the 1924 drop was in the last three months of the year. In 1924 the Welsh ports imported bars that, if made in this district, would have given five weeks' full time work for the whole of their works. That the district had had a better time than any other was perhaps explained by the success of the stabilisation scheme. The comparative cost of transport, labour and taxation in this country gave scarcely a ray of hope, although every effort had been made to bring down prices to the lowest possible level.

South Wales Coalowners.

Mr. W. North Lewis, chairman of Insoles, Limited, and Windsor Steam Coal Company, Limited, has been elected chairman of the Monmouthshire and South Wales Coalowners' Association for the ensuing year, and the vice-chairman is Mr. Edmund L. Hann, the general manager of the Powell Duffryn Steam Coal Company, Limited. The report presented to the annual meeting of the Association by the secretary showed that, compared with 1923, the output had decreased by 3,129,418 tons. In the Swansea area, owing to the comparative prosperity of the anthracite trade, the decrease was only about 2.7 per cent., but in the Cardiff area it was about 7 per cent.

Colliery Transfer.

The Mynydd Newydd Colliery, employing between 300 and 400 men, which for years supplied the works of Messrs. Vivian and Sons, smelters, of Swansea, with fuel, has been sold through Messrs. Richard and Matthews, colliery agents, for about £30,000, to a Swansea syndicate.

Current Business.

Operations on current account in steam coals have been on a very meagre scale, and the tone all round is quiet and easy. Values in all sections of the market are unsteady and irregular, and are entirely governed by the individual position of undertakings. There is scarcely a single quality that can be described as in good demand. Best Admiralty large coal ranges from 26s. to 27s., while seconds are about 25s. to 26s. Small coals are fairly plentiful, except in the case of the best sorts, while patent fuel and coke meet with a quiet demand. Anthracite coals on the whole show very little alteration, but are no more than about steady.

LAUNCHES AND TRIAL TRIPS.

INVERLAGO, shallow-draught oil vessel; built by Harland and Wolff, Limited, to the order of Andrew Weir and Co.; dimensions, 315ft. by 50ft.; 2360 gross tonnage. Engines, twin-screw triple-expansion, pressure 180 lb.; launch, February 28th.

OUED MELLAH, oil tanker; built by Philip and Son, Limited, to the order of Portuguese owners; dimensions, 140ft. by 30ft. by 9ft. 6in.; to carry 400 tons. Engines, 13½in., 28in., by 20in. stroke; constructed by the builders; trial trip, February 28th.

JOHN A. HOLLOWAY, steamer; built by Earle's Shipbuilding and Engineering Company, Limited, to the order of the Eastern Steamship Company; dimensions, 258ft. by 44ft. by 20ft.; to carry 2510 tons deadweight. Engines, triple-expansion, surface condensing, 17in., 28in., 46in. by 33in. stroke, pressure 180 lb.; constructed by the builders; launch, February 28th.

DINNER OF THE MACHINE TOOL TRADES' ASSOCIATION.—The annual dinner of the Machine Tool Trades' Association was held at the Trocadero on Wednesday evening, and was very well attended. The president of the Association, Sir Alfred Herbert, occupied the chair, and the principal guests were Mr. Amery, Secretary of State for the Colonies, and Mr. Stanley Machin. Acknowledging the toast of His Majesty's Ministers, the former dealt at considerable length with the economic conditions of the country, and dwelt particularly on the decadence of skill. He urged the importance of replacing the now obsolete or obsolescent apprenticeship by some effective equivalent, and spoke of the necessity of regarding the Empire as a single whole. He appealed to young men to think of the Colonies as places where they could find an outlet for their energies. Mr. Stanley Machin also responded to this toast. The toast of the guests was ably proposed by Mr. Lang, of John Lang and Sons, and acknowledged by Mr. Maunsell, of the Southern Railway.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 24/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 11 6	—
No. 1 Foundry	4 11 6	—
No. 3 Foundry	4 9 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 5 0	4 5 0
No. 1	4 5 6	4 5 6
Cleveland—		
No. 1	4 3 0	4 3 0
Silicious Iron	4 3 0	4 3 0
No. 3 G.M.B.	3 18 0	3 18 0
No. 4 Foundry	3 17 0	3 17 0
No. 4 Forge	3 16 0	3 16 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 14 0 to 3 15 0	
,, Forge	3 9 0 to 3 10 0	
(3) Derbyshire—		
No. 3 Foundry	3 18 0 to 3 19 0	
Forge	3 15 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	3 17 6	—
Basic	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 0 0 (a); 5 2 6 (b); 5 5 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. Coast—		
Common Bars	12 0 0	—
Lancs.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0 to 13 2 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ¾in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¾in.	11 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£18 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 5 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 5 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
Manchester—		
Bars (Round)	9 15 0 to 10 0 0	
,, (others)	9 10 0 to 9 15 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 10 0 to 9 15 0	
,, (Lancs. Boiler)	13 0 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	9 0 0 to 9 15 0	
Billets and Sheet-bars	7 0 0 to 7 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	22/1½ to 22/9
Block Tin (cash)	242 5 0
,, (three months)	245 15 0
Copper (cash)	63 12 6
,, (three months)	64 12 6
Spanish Lead (cash)	37 2 6
,, (three months)	36 0 0
Spelter (cash)	35 17 6
,, (three months)	35 6 3
Manchester—	
Copper, Best Selected Ingots	68 10 0
,, Electrolytic	69 10 0
,, Strong Sheets	95 0 0
,, Tubes (Basis Price)	‡ 0 1 1½
Brass Tubes (Basis price)	‡ 0 1 0½
,, Condenser	‡ 0 1 2½
Lead, English	40 0 0
,, Foreign	38 10 0

‡ A fall is expected during the week.

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 10 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£42 10 0	16/-
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.75 p.c. carbon	£58 0 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 5 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	7/3 per lb.	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	16/-
,, ,, Ell	18/3
,, ,, Splint	19/- to 22/-
,, ,, Trebles	16/-
,, ,, Doubles	14/9
,, ,, Singles	14/-
Ayrshire—	
(f.o.b. Ports)—Steam	18/-
,, ,, Splints	19/-
,, ,, Trebles	16/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	14/4½ to 17/-
Screened Navigation	23/-
Trebles	15/6 to 17/-
Doubles	14/6 to 15/-
Singles	14/-
Lothians—	
(f.o.b. Leith)—Best Steam	15/7½
Secondary Steam	15/-
Trebles	15/-
Doubles	14/4½
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	28/-
Household	45/- to 58/4
Coke	30/-
Northumberland—	
Best Steams	18/6
Second Steams	17/6
Steam Smalls	10/9
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
Durham—	
Best Gas	21/-
Second	17/9 to 18/-
Household	23/6 to 25/-
Foundry Coke	23/- to 23/6

Sheffield—	Inland.	Export.
Best Hand-picked Branch	30/- to 33/-	—
Barnsley Best Silkstone	26/- to 28/-	—
Derbyshire Best Brights	26/- to 31/-	—
,, ,, House	24/- to 26/-	—
,, ,, Large Nuts	22/6 to 25/-	—
,, ,, Small	14/- to 16/-	—
Yorkshire Hards	18/- to 22/-	—
Derbyshire ,,	18/6 to 22/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	8/6 to 10/-	—
Smalls	4/- to 6/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	20/9 to 21/9

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	25/- to 26/-
Best Dry Large	25/6 to 26/-
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/- to 24/6
Western Valley ,,	23/- to 24/-
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/- to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	22/- to 28/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 22/6
,, ,, Through	18/- to 20/-
,, ,, Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/6
Pitwood (ex ship)	24/- to 24/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	43/6 to 45/6
Seconds	32/6 to 35/-
Red Vein	29/- to 32/-
Machine-made Cobbles	45/- to 50/-
Nuts	50/- to 52/6
Beans	44/- to 45/-
Peas	20/- to 23/6
Breaker Duff	9/- to 9/6
Rubbly Culm	9/3 to 9/9
Steam Coals:	
Large	22/- to 24/-
Seconds	21/- to 22/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Industrial Values.

THE extremely heavy depreciation of industrial stocks, chiefly engineering and metallurgical, during the past year is characteristic of the change that has taken place in the industrial situation, and if the fall had only manifested itself recently there might be some reason for supposing that it was due solely to the experimental legislation of the present Socialist Government. It may, at any rate, be admitted that the depreciation has been accelerated by the taxes and restrictions of all kinds that have been imposed upon industry until investors have come to believe that there is nothing to be made out of industry at all. Moreover, efforts are made to put increasing charges on visible capital, and it is therefore only natural that capital should remain invisible. It is reported that even some of the big firms are in an unsatisfactory financial position on account of the withdrawal of discount facilities by the banks, and it is certain that the great majority of makers find it difficult to carry on when they are often obliged to grant much longer credits than are accorded to themselves. This, however, is not the only cause of the depreciation of industrial stocks. The volume of business has fallen off partly through the slowing down of reconstruction work, and partly through production having largely exceeded the home capacity of consumption, which has been further curtailed by the country's lower purchasing power, due to the taxation and to the monetary depreciation. Therefore, the only hope for the future lies in reviving confidence in industry and in developing business with foreign markets. This is bringing prominently to the fore the necessity of revising the country's fiscal policy.

The Tariff Bill.

That the Tariff Bill is likely to undergo considerable changes before it is introduced into the Chamber of Deputies is implied by the statements of the Minister of Commerce, who has explained the great difficulty the Government experiences in entering into commercial arrangements with other countries. The system of a maximum and a minimum tariff was adopted as being best suited to the special conditions of home industries, but, as no concession can be made upon the minimum tariff, France has really nothing to offer in exchange for concessions from other countries. It is for that reason that the negotiations for treaties of commerce with Belgium and Germany have failed. It is hoped that in both cases temporary arrangements will be come to pending a final treaty, but such arrangements are only possible in the event of some assurance being given that the future Tariff Bill will allow of treaties being carried through on a perfectly reciprocal basis. The Minister of Commerce suggests that the only means of negotiating with other countries, and of facilitating foreign trade, is to give more elasticity to the minimum tariff. It may be necessary to raise the minimum, but the negotiators should be empowered to make concessions that may be necessary to secure reciprocal treatment elsewhere. It is fairly certain that this official statement has been made with a view of preparing the way for drastic changes in the fiscal policy. It is absolutely necessary to treat with Germany for the sake of the future of Alsace-Lorraine, and, as Germany appears to have the upper hand in the negotiations, the French have been obliged to promise much greater concessions than they had intended to do, with the result that Germany comes in for many things on the minimum tariff, with further advantages equivalent to the most favoured nation treatment. Belgium protests that she will not enter into a treaty of commerce unless she can get better terms than Germany. Consequently the rigid minimum tariff must go, and sufficient elasticity must be allowed to provide concessions to meet the special requirements of each country. The laborious negotiations now proceeding with Belgium and Germany will probably prepare the way eventually for a treaty of commerce with Great Britain under more favourable conditions than exist at present.

Shipbuilding Credits.

The efforts of the Government to placate shipowners by offering financial grants to compensate them partially for the losses they would sustain through the adoption of an eight hours' day for seamen are meeting with no success. Powers are being sought in Parliament for the creation of an Office National de Crédit Maritime which will make the grants and will also lend money at a low rate of interest to shipbuilders in the hope that this financial assistance will do something to stimulate an industry which has long been in a very bad way. The funds are to be raised by a tax on travellers and goods arriving at the ports. Both the shipowners and shipbuilders declare that they desire to have nothing to do with a State institution which will necessarily aim at exercising a certain control over the shipping industry, and the commercial bodies interested in the prosperity of the sea-borne trade condemn absolutely a system of taxation that would compromise the considerable efforts the various ports are making to foster a great sea-going traffic. The Socialist attempt to control more or less indirectly the great traffic interests is meeting with a discouraging reception.

Suction Gas Lorries.

Some further trials of lorries running on suction gas produced from charcoal are to be organised this year by the Office National des Recherches et Inventions. Previous tests showed that, while there is a considerable saving in fuel cost as compared with petrol, the lower power developed, the heavier expenses involved by the upkeep, and the higher interest in capital reduced the net economy to 25 per cent., and as, since then, the price of charcoal has increased, there is necessarily a still further reduction in economy. Nevertheless, the use of a native fuel in place of imported petrol is regarded as a matter of considerable importance in this country, and suction gas would receive attention even if its economy were appreciably less.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics

When an abridgment is not illustrated the Specification is without drawings.

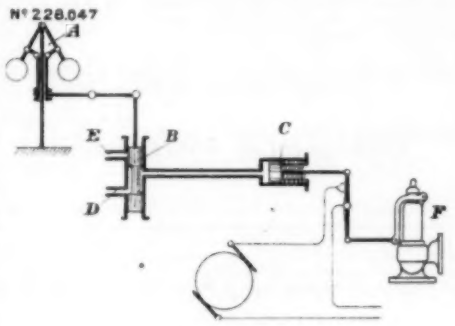
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

228,047. May 9th, 1924.—SAFETY LEVICES, J. V. Blomquist and K. F. Wessblad, Lästmakaregatan 18, Stockholm, Sweden.

This safety device is intended to safeguard boilers having rotary tubes from failure through the rotation stopping and the tops of the tubes consequently becoming dry. The centrifugal

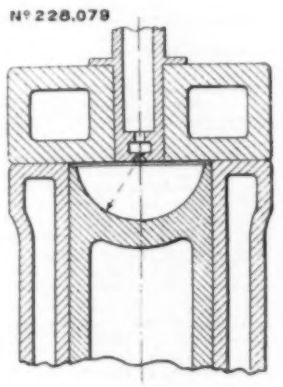


governor A is driven in unison with the boiler tubes and controls the piston valve B. When the tubes are running the piston C is open to the atmosphere by way of the passage D, but if rotation ceases steam pressure, admitted at E, forces out the piston C, opens the main safety valve F, and breaks the circuit of the motor driving the oil fuel pumps.—*January 29th*, 1925.

INTERNAL COMBUSTION ENGINES.

228,079. September 18th, 1923.—COMBUSTION SPACES, T. Shields, 30, Southampton-buildings, London, W.C. 2.

In this engine the combustion space is formed by a hemispherical recess in the piston and the cylinder cover is flat. It is claimed that eddy currents are consequently minimised,

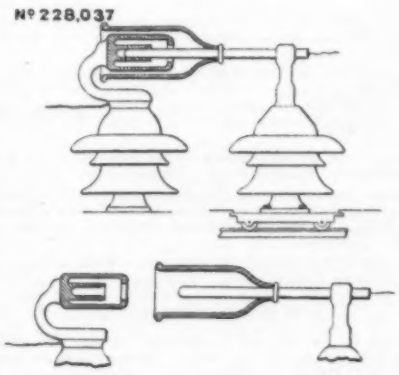


and the fuel spray uniformly penetrates the air in contact with the piston, while the surface area of the cylinder cover is as small as possible. It is said that an engine of this type has a fuel consumption of 177 grammes per horse-power hour, and a mean pressure of 7.8 atmospheres.—*January 29th*, 1925.

SWITCHGEAR.

228,037. April 5th, 1924.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SWITCHES, *The British Thomson-Houston Company, Limited, of Crown House, W.C. 2.*

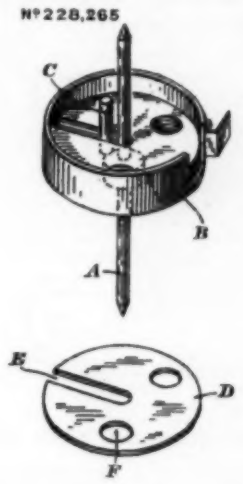
This invention relates to air break switches for outdoor use,



and the principle on which it operates will readily be understood from the drawing. Hoods are provided for protecting the switch contacts from the accumulations of ice, snow, &c., irrespective of whether the switch is opened or closed. The moving contact is mounted on a truck, as shown in the top right-hand drawing.—*January 29th*, 1925.

228,265. November 1st, 1923.—IMPROVEMENTS IN OR RELATING TO ELECTRIC RELAYS, A. Reyrolle and Co., Limited, of Hebburn-on-Tyne, Durham; Bruce Hamer Lorson, of Waverley, Tynemouth; and Nalder Brothers and Thompson, Limited, and Francis Henry Nalder, both of 97a, Dalston-lane, E. 8.

According to this invention the inverse time delay action or time lag of a relay is made adjustable by altering the inertia of the rotary moving member of the relay, the alteration being made by the addition of one or more inertia discs or rings to the spindle of the moving member. In the drawing A is the spindle

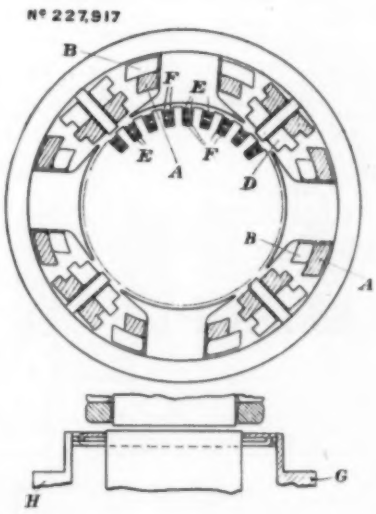


of the relay. Upon this spindle a light cup B is mounted and a pin C is fixed in the cup. Inertia is imparted to the spindle by placing one or more discs D in the cup, part of the cup being cut away to facilitate the addition of the discs. The slot E engages with the spindle A and the pin C so that the disc cannot move round the cup. As the cup is extremely light its inertia can be disregarded and the desired amount of inertia can be added by placing the necessary number of discs in the cup. The holes F in the discs are provided to compensate for the slot E.—*February 2nd*, 1925.

DYNAMOS AND MOTORS.

227,917. October 24th, 1923.—IMPROVEMENTS IN AND RELATING TO DYNAMO ELECTRIC MACHINES, Tilling's Motors, Limited, and Harold Kenneth Whitehorn, both of Victoria Works, Maidstone, Kent.

This invention is applicable to machines of the double commutator type and particularly to systems in which the armature windings are arranged to be connected in series or in parallel at will, and it has special reference to motors employed with machines of the petrol-electric type. In series parallel control vehicle transmission systems it is very important that the two systems to be paralleled should have exactly similar characteristics, as surging effects are otherwise liable to occur, and it has been the usual practice when utilising a double commutator machine in such systems for the winding connected to one commutator



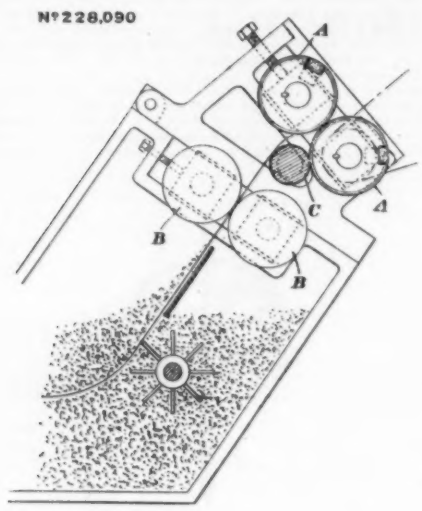
to lie in the bottom portion of the slots and the winding connected to the other commutator to lie in the upper portion. According to this invention each of the main poles has two separate coils A and B corresponding to two distinct armature windings arranged with the coil A adjacent to the yoke on one pole and remote from the yoke on the next pole. Each commutating pole also has two coils similarly arranged, one being shown at D. The armature, which is arranged for three coils per slot, has conductors E and F, the conductors of each winding being alternately in the upper and in the lower part of the slot. The conductors F are all connected to the commutator G, and the conductors E to the commutator H. Alternative arrangements of the armature conductors are also illustrated.—*January 26th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

228,090. November 4th, 1924.—CLEANING TIN-PLATES, D. S. Rees and J. H. Cole, Arcol Works, Maryland-road, Pontymister, Mon.

The inventors state that in cleaning tin-plates, in the usual manner, by drawing them through bran, the lower side of the plate is not cleaned so thoroughly as the upper surface. They thus add to the ordinary brannor an extra pair of feed rolls A A,

and the usual feed rolls B B act more as guide rolls. Between the two sets there is a third roll C, which is driven against the direction of movement of the plate by frictional contact with

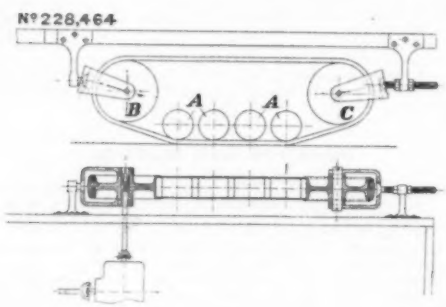


the lower of the two rolls A, and consequently cleans the lower face of the plate. All the rolls are covered with sheepskin.—*January 29th*, 1925.

MOTOR CARS AND ROAD TRAFFIC

228,464. August 25th, 1924.—ENDLESS TRACKS, A. Kegresse 53, Rue Balard, Paris, France.

According to this invention neither of the bearing rollers A A is provided with flanges, but the two end guide pulleys B and C

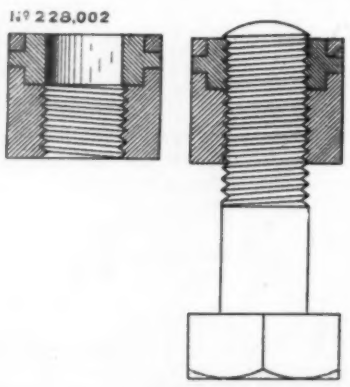


are both flanged. The guide pulleys are carried by frames, which are secured to the chassis by universal joints as shown The pulley which acts as the driver has the power transmitted to it through a double universal joint, while the opposite pulley is provided with tension gear.—*February 5th*, 1925.

MISCELLANEOUS.

228,002. January 21st, 1924.—LOCK NUTS, A. Pay and J. A. MacMay, Paramaribo, Surinam, Dutch Guiana.

In this lock nut a recess is formed, as shown in the drawing, and is filled with soft metal, such as an alloy of tin and lead in



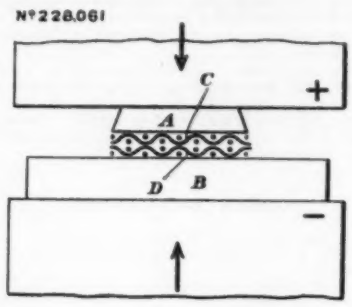
equal proportions. The thread is not continued through the soft metal part of the nut, and the nut is put on the bolt forcibly. The nut can be removed by melting out the white metal, but will not, it is said, shake loose even on a steam stamp mill.—*January 29th*, 1925.

228,449. August 5th, 1924.—A HIGH-TEMPERATURE ALLOY, F. M. Ekert, 19, Seidnitzerstrasse, Dresden-Blasewitz, Germany.

In this specification the inventor sets out by suggesting that the ideal alloy for resisting high temperatures in such services as for valves or packings would be one of nickel and lead, but he points out that these two metals are very difficult to alloy. He thus suggests that the lead, in the form of a lead-copper-tin alloy, should be melted at a temperature of 2000 deg. Fah. and poured into a nickel-copper-tin alloy melted at 2700 deg. Fah. He says that the addition of tungsten enables the metal to be drawn into wire. The following proportions are given for the alloy :—Nickel, 10—30 per cent.; copper, 10—50 per cent.; tin, 1—20 per cent.; zinc, 1—10 per cent.; phosphorus, ¼—5 per cent.; manganese, ¼—5 per cent.; chromium, ¼—5 per cent.; tungsten, ¼—5 per cent.; lead, 20—70 per cent.—*February 5th*, 1925.

228,061. June 24th, 1924.—WELDING, *G. B. Ellis*, 70, *Chancery-lane, London, W.C. 2.*

The inventors state that if, in electrically welding together copper and steel, pieces of wire mesh are inserted in the joint,



a good weld can be obtained. In the drawing A is the piece of copper and B the steel. The wire mesh C is of brass, and that at D of steel. The actual welding is carried out in the normal manner.—*January 29th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

EX-BRITISH WESTINGHOUSE ASSOCIATION.—Holborn Restaurant, London, W.C. 1. Seventh annual re-union dinner. 6.45 p.m.

INSTITUTION OF CIVIL ENGINEERS : BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. Lecture, "The Wandle Valley Sewage Disposal Works," by Mr. Hugh P. Raikes. 6 p.m.

INSTITUTE OF METALS : SWANSEA LOCAL SECTION.—Metallurgical Department of the University, Singleton Park, Swansea. General discussion. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : LONDON STUDENTS' SECTION.—Anderton's Hotel, Fleet-street, London, E.C. 4. Annual dinner. 6.45 for 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Reports to the Cutting Tools Research Committee. "The Action of Cutting Tools," by Professor E. G. Coker ; and "Experiments with Lathe Tools on Fine Cuts, and Some Physical Properties of the Tool Steels and Metal Operated Upon," by Messrs. Dempster Smith and Arthur Leigh. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS, 39, Victoria-street, London, S.W. 1. Lecturette, "Notes on Methods of Producing Modern High-grade Machine Tools," by Mr. A. P. Bale. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, S.W. 7. Papers, "The Variation of Young's Modulus at High Temperatures," by Mr. J. P. Andrews ; "The Critical Velocity of Flow Past Objects of Aerofoil Section," by Dr. E. G. Richardson ; "A Focussing Method of Crystal Powder Analysis by X-Rays," by Dr. J. Brentano. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Beginnings of the Science of Language," by Professor Gilbert Murray. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Room 24, Royal Technical College, George-street, Glasgow. Paper, "Fuel in the Iron and Steel Industry," by Mr. E. C. Evans. 7 p.m.

SATURDAY, MARCH 14TH.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH.—College of Technology, Sackville-street, Manchester. Lecture, "Oil Sand Cores," by Mr. G. Edgington. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Counting of the Atoms, III:," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 16TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "The Steam Ejector Air Pump and its Applications," by Professor G. F. Charnock. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "A Few Features of Early Car Design," by Mr. E. R. Caflyn. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS : SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS : NEWCASTLE-UPON-TYNE ASSOCIATION.—Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne. Paper, "Coal Shipping Staiths : Their Lay-out, Construction and Operation," by Mr. J. Taylor Thompson. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—Criterion Restaurant, Piccadilly, London, W. 1. Annual dinner. 7 for 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS : NORTH-WESTERN SECTION.—Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. "Industrial Electric Vehicles," by Mr. J. R. Oliver. 7.15 p.m.

WOMEN'S ELECTRICAL ASSOCIATION.—Visit to the Osram Lamp Works, Hammersmith. 2.30 p.m.

TUESDAY, MARCH 17TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. Paper, "Motor Passenger Vessels," by Mr. A. C. Hardy. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS : WOLVERHAMPTON CENTRE.—The Engineers' Club, Queen's-street, Wolverhampton. Paper, "Experiments on a High-speed Gas Engine," by Mr. A. F. Burstall. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : NORTH MIDLAND STUDENTS' SECTION.—The University, Leeds. Paper, "High-pressure and High-temperature Steam," by Messrs. W. R. T. Skinner and G. E. Barrett. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Evolution of the Scientific Instrument—II.," by Professor E. N. da C. Andrade. 5.15 p.m.

WEDNESDAY, MARCH 18TH.

BRITISH COLD STORAGE AND ICE ASSOCIATION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Small Refrigerating Plants and the Thermodynamical Properties of Refrigerating Liquids," by Dr. Ezer Griffiths and Mr. J. H. Awbery. 5.30 p.m.

INSTITUTE OF METALS : NORTH-EAST COAST LOCAL SECTION —Electrical Engineering Theatre, Armstrong College, Newcastle-on-Tyne. Paper, "Electric Furnaces," by Mr. A. Glynne Lobley. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Modern Servos and Front Axle Control," by Mr. W. A. Robotham. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Students' meeting. Paper, "The Littoral Drift of Shingle," by Mr. T. W. Marsh. 6 p.m.

THURSDAY, MARCH 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. Graduates' meeting. Paper, "Sleeve Valve Control for High-speed Engines, by Mr. J. A. Barr. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Permanent Magnets in Theory and Practice," by Mr. S. Evershed. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS : NORTH-WESTERN BRANCH.—The Engineers' Club, Manchester. Annual dinner. 6.45 for 7.15 p.m.

FRIDAY, MARCH 20TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Modern Transport," by Mr. S. H. Hole. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Soaps and the Theory of Colloids," by Professor J. W. McBain. 9 p.m.

SATURDAY, MARCH 21ST.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Manchester. Lecture, "Plate Moulding and the Patternmaker," by Mr. H. Stead, 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle-street, London, W. 1. "The Counting of the Atoms—IV., by Sir Ernest Rutherford. 3 p.m.

TUESDAY, MARCH 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Automobile Steels and Irons," by Mr. C. Walker. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : NORTH MIDLAND CENTRE.—Hotel Metropole, King-street, Leeds. Paper, "Design of Electrical Plant, Control Gear and Connections for Protection against Shock, Fire, and Faults," by Mr. H. W. Clothier 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Discussion on "Internal Combustion Turbines," by Professor W. J. Goudie ; and "The Manufacture of Brass Condenser Tubes, with some Notes on an Alternative Alloy," by Messrs. G. H. Whiteman and A. Spittle. 7.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Ye Olde Castle Restaurant, Castle-place, Belfast. Irish District meeting. 1 p.m.

WEDNESDAY, MARCH 25TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Birmingham Graduates' visit to the works of Morris Commercial Motors, Limited, Soho, Birmingham. 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS : NORTH OF ENGLAND CENTRE.—Milton Hall, 244, Deansgate, Manchester. Paper, "Experiments on a High-speed Gas Engine," by Mr. A. F. Burstall. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Joint meeting with the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-engine Trials. "A Standard Code for Tabulating the Results of a Steam-generating Plant Trial," by Mr. W. H. Patchell. 6 p.m.

THURSDAY, MARCH 26TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Training School of Vauxhall Motors, Limited, Luton. Luton Graduates' meeting. Paper. "Maximum Performance and Balance of a Four-cylinder Engine," by Mr. Gibson. 7.30 p.m.

FRIDAY, MARCH 27TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Holborn Restaurant, London, W.C. 1. South-Eastern District meeting, followed by annual dinner. 4.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, London, E. 1. Annual meeting. 6.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Council House, Smethwick, Birmingham. West Midland District meeting. 2 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Irrigation Engineering in Burma," by Mr. A. P. Morris. 7.30 p.m.

SATURDAY, MARCH 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS. — London Graduates' visit to the works of the Vacuum Oil Company, Limited, York-road, Wandsworth. 2.30 p.m.